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SENATE

REPORT
No. 97-449

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION AUTHORIZATION ACT

MAY 28, 1982.—Ordered to be printed
Filed under authority of the order of the Senate of May 12 (legislative day, May 11), 1982

Mr. PACKWOOD, from the Committee on Commerce, Science, and Transportation, submitted the following

REPORT

together with

ADDITIONAL VIEWS

[To accompany S. 2604]

The Committee on Commerce, Science, and Transportation, having considered an original bill (S. 2604) to authorize appropriations to the National Aeronautics and Space Administration for research and development, construction of facilities, and research and program management, and for other purposes, reports favorably thereon and recommends that the bill do pass.

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S263-18

COMMITTEE ADJUSTMENTS TO NASA REQUEST FOR FISCAL YEAR 1983—SUMMARY

Fiscal year 1983	Administration request	Committee authorization
Research and development:		
Space Shuttle	$1,718,000,000	$1,808,000,000
Space flight operations	1,707,000,000	1,448,000,000
Expendable launch vehicles	42,800,000	42,800,000
Physics and astronomy	471,700,000	491,700,000
Planetary exploration	154,600,000	194,000,000
Life sciences	55,700,000	55,700,000
Space applications	316,300,000	336,300,000
Technology utilization	4,000,000	9,000,000
Aeronautical research and technology	232,000,000	296,000,000
Space research and technology	123,000,000	133,000,000
Energy technology		
Tracking and data acquisition	508,900,000	508,900,000
Total	5,334,000,000	5,324,000,000
Construction of facilities	100,000,000	110,000,000
Research and program management	1,178,900,000	1,178,900,000
Grand total	6,612,900,000	6,612,900,000

Purpose of the Bill

The purpose of this bill is to authorize appropriations to the National Aeronautics and Space Administration totaling $6,612,900,000 for fiscal year 1983 as follows:

Fiscal year 1983	Budget request	Committee authorization
Research and development	$5,334,000,000	$5,324,000,000
Construction of facilities	100,000,000	110,000,000
Research and program management	1,178,900,000	6,612,900,000

Legislative History

On February 8, 1982, the fiscal year 1983 budget request for the National Aeronautics and Space Administration (NASA) was submitted to Congress. The Committee held hearings on February 23 and 25, March 16, 18, and 30 and April 1 to consider the budget request. Testimony was received from the NASA Administrator, various Associate Administrators of NASA, representatives from the Department of Defense, and outside witnesses. On May 11, 1982, the Committee considered an original bill and ordered it reported without amendment.

Summary

For fiscal year 1983, NASA requested a budget totaling $6,612,900 of which $5,334,000 was for Research and Development, $100,000,000 for Construction of Facilities, and $1,178,000 for Research and Program Management.

The Space Transportation System is funded at a level to continue production of the first four orbiters and support a flight rate and build up to 24 flights per year. The Space Flight Operations funding level will support five operational Space Shuttle flights in fiscal year 1983. The increase from the budget of $3,090,100 in fiscal year 1982 to $3,467,800 for the Space Transportation System primarily supports NASA's preparations for the operational phase of the Space Shuttle program.

The budget request for Space Science Programs increased from $568,000 in fiscal year 1982 to $682,000 in fiscal year 1983. The increase is largely due to peak funding levels in major flight programs. However, the mission operations and data analysis portions of the budget which represent the continued operations of existing spacecraft as well as support for basic reseach and technology and data reduction from past missions has been severely reduced. Specifically, the planetary program budget request for fiscal year 1983 is $154,600,000, down from $205,000,000 in fiscal year 1982. NASA requested $316,-300,000 in fiscal year 1983 for space applications program. This is a reduction from $325,800,000 in fiscal year 1982. For Space Research and Technology the request was $123,000,000. NASA's request for technology utilization for fiscal year 1983 was $4 million. This represents a reduction of 50 percent from NASA's fiscal year 1982 operating plan.

The request for Aeronautical Research and Technology was $232,-000,000. The budget request for the research and technology base is $182,000,000, and the request for systems technology programs is $50 million. While the overall budget request represents a reduction of 18.6 percent from the amount authorized in fiscal year 1982, the systems technology request for fiscal year 1983 is 61 percent below that which was authorized for fiscal year 1982 and 53 percent below the fiscal year 1982 request.

NASA requested $508,900,000 for Tracking and Data Acquisition programs in fiscal year 1983. For Construction of Facilities, the request was $100 million. The budget request for Research and Program Management was $1,178,900,000.

The Committee carefully reviewed the fiscal year 1983 budget request and recommends a total of $6,612.900,000 be authorized which is the funding level requested by NASA. Whereas the Committee continues to place the Space Shuttle and its transition from a research and development program to an operational system as the highest priority, the Committee is extremely concerned about the erosion of other NASA programs at the expense of the Space Shuttle. Since fiscal year 1980, the Shuttle program has grown by 10 percent in constant dollars and space science research, space applications and aeronautic research and technology have declined by an average of 26 percent.

The 1958 Space Act lists as one of its principal objectives "The preservation of the role of the United States as a leader in aeronautical and space science and technology and in the application thereof to conduct of peaceful activities within and outside the atmosphere." Careful analysis shows that the administration's budget decisions

made the fiscal years 1982 and 1983 time period do not comply with the objectives of the Space Act. The Committe believes it is now time to restore the balance between the Shuttle program which provides a national capability for both the civilian and military sectors and those programs which support the space and aeronautics research and technology base upon which this Nation's competitive edge, economic stability and national security depend.

The Committee is also concerned that the Department of Defense is not paying its fair share for Shuttle operations. Consequently, the Committee included language in the bill directing the Department of Defense to reimburse NASA for full costs of placing Department of Defense payloads in orbit using the Space Shuttle. These funds would be paid on a yearly basis and at the same rate that NASA pays for launches of civilian flights, with adjustment for services of equal value. The Committee made a reduction of $409 million in Space Flight Operations to reflect this policy.

The Committee provided:

$20 million for Physics and Astronomy to be applied to the Explorer program, mission operations and data analysis, research and analysis, and the suborbital program.

$40 million for Planetary Exploration to be applied to mission operations and data analysis and research and analysis.

$64 million for Aeronautical Research and Technology to maintain a strong systems technology program $20 million for advanced satellite communications.

$90 million for the fifth Shuttle orbiter

$150 million for space transportation capability development to be applied to development of the centaur high energy upper stage

$5 million for the Technology Utilization program

$10 million for Space Research and Technology

$10 million for Construction of Facilities.

The authorization for NASA for fiscal year 1983 contains no new program starts. However, the Committee believes that a strong civilian space program is vital to the leadership of this nation in space and contributes significantly to the economic as well as the technological strength of this Nation.

RESEARCH AND DEVELOPMENT—SUMMARY

Fiscal year 1983	Administration request	Committee authorization
Research and development:		
Space Shuttle	$1,718,000,000	$1,808,000,000
Space flight operations	1,707,000,000	1,448,000,000
Expendable launch vehicles	42,800,000	42,800,000
Physics and astronomy	471,700,000	491,700,000
Planetary exploration	154,600,000	194,000,000
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Energy technology		
Tracking and data acquisition	508,900,000	508,900,000
Total	5,334,000,000	5,324,000,000

SPACE SHUTTLE PROGRAM, $1,808,000,000

The Space Shuttle is the key element of a versatile and unique space transportation system that will provide a wide variety of national and international users with routine roundtrip access to space beginning in 1982. The Space Shuttle is the first reusable space vehicle, and is configured to carry many different types of payloads to and from low Earth orbit. The Shuttle provides multipurpose space operations for Earth applications, scientific, and defense requirements.

The Space Shuttle is, however, much more than just a transportation vehicle. It will offer unique capabilities that cannot be achieved with today's expendable launch vehicles—to retrieve payloads from orbit for resuse; to service and repair satellites in space; to transport to orbit, operate, and return space laboratories; to transport materials and equipment to orbit; and to perform rescue missions. These capabilities will greatly enhance flexibility and productivity, and result in savings in the cost of space operations.

The Space Shuttle consists of four basic flight hardware elements—the orbiter, the main engines, an expendable external propellant tank (ET), and twin solid rocket boosters (SRB)—plus launch and landing systems. The orbiter is the reusable spacecraft portion of the Space Shuttle. Its large payload volume of 285 cubic meters (370 cubic yards) and cargo carrying capacity of up to 29,500 kilograms (65,000 pounds) will permit payloads to be built to less restrictive design requirements. The orbiter vehicle will carry personnel and payloads into orbit to perform their assigned tasks and return them to Earth. The orbiter is roughly the size of a DC–9 aircraft and contains three liquid fueled reusable main engines. It also provides a habitable environment for a crew which will include scientists and engineers.

The Space Shuttle usually will have a crew of three: the commander, the pilot, and the mission specialist. On some missions, up to four more mission or payload specialists may be added. The crew will experience forces not greater than three times that of gravity during launch and landing. They will be able to perform their work in a shirt-sleeve environment.

Three highly successful test flights of the Space Shuttle have been accomplished. Prelaunch preparations are underway for the fourth and final (STS–4) of the Space Shuttle test flights. Orbiter 102 (Columbia) is currently in the Kennedy Space Center's Orbiter Processing Facility (OPF) undergoing checkout. The STS–4 launch is scheduled for June 27, 1982, and is scheduled to land at the Dryden Flight Research Facility—Edwards Air Force Base.

The main engines performed flawlessly during the first three flights of the Columbia, requiring only inspections and minor maintenance to prepare them for the future flights. Testing was initiated on the full power level (FPL) version of the main engine during fiscal year 1981. The technical problems which were discovered in this early development testing (two main injector liquid oxygen pump failures, a fuel preburner liquid oxygen pump failure, and a fuel turbopump turbine failure) have been corrected. Testing is continuing in support of the FPL certification program which was initiated early in fiscal year 1982.

The external tank for the fourth launch has been delivered to the Kennedy Space Center (KSC). The two remaining tanks of the heavyweight configuration, along with the first six lightweight tanks, are in various stages of manufacture at the Michoud Assembly Facility.

At the Kennedy Space Center, the Space Shuttle processing facilities and ground support equipment are fully operational and have successfully supported the vehicle assembly, tests, servicing, checkout and launches for STS–1, STS–2, and STS–3. The processing activities include the replacement of defective vehicle parts, changeout of payloads, orbiter deservicing and ferrying from the Dryden Flight Research Facility and White Sands Space Harbor landing site to the Kennedy Space Center, and retrieval of SRB's from the Atlantic Ocean and subsequent disassembly. The processing procedures, software, and launch processing system are functioning well. Assembly of the SRB and ET elements and premate testing of the orbiter is underway in preparation for launching STS–4 in June 1984.

The second, third, and fourth flight orbiters are in various stages of manufacturing. Challenger, Orbiter 099, is scheduled for delivery in mid-1982. Substantial parts of its airframe were used during the development phase to test the structural dynamics of the Shuttle vehicle under various load conditions; the modifications to convert it into a flight orbiter are nearly complete. Discovery, Orbiter 103, is well into the structural assembly phase at the Rockwell facility in Downey, Calif., and at the various subcontractor facilities around the country; OV–103 is planned for delivery in September 1983. Atlantis, Orbiter 104, is in the early stages of primary structure build-up; its delivery is scheduled to occur in December 1984.

Within the available funding for fiscal year 1982, the highest priority has been assigned to maintaining the delivery schedule for Orbiter-099 and Orbiter-103; certain Orbiter-104 activities scheduled for fiscal year 1982 may have to be rephased. Procurement of the necessary supporting hardware, such as the remote manipulator system and television cameras, is underway on a schedule which supports the above orbiter delivery dates.

The production main engines required to support the testing and flight program are currently being delivered. These engines are constructed in the full power level configuration, providing thrust levels at 109 percent of the rated power level engines used for the first flights of Orbiter Vehicle-102, Columbia. Seven production engines are scheduled for delivery in fiscal year 1982.

At the Kennedy Space Center, a number of the additional, second line processing facilities are nearing completion. Activation of the second bay of the Orbiter Processing Facility, the second SRB and ET checkout bay and second vehicle assembly bay in the Vehicle Assembly Building, and the second mobile launcher platform have been accelerated to receive and process Challenger independently of Columbia when Challenger is delivered in mid-1982. The readiness date for the software development facility in the launch control center firing room is also being accelerated to support this independent second line. Work on the second firing room, second launch pad, and increased rate capability in other work stations is underway, with activation planned for subsequent years.

Milestone schedule

First orbital test flight, April 12–14, 1981.
Second orbital test flight, November 12–14, 1981.
Third orbital test flight, March 22–30, 1982.
Fourth orbital test flight, June, 1982.
Initial operational capability (fifth orbital flight), 3rd Quarter 1982.
Delivery of 2nd Orbiter (099), June, 1982.
Delivery of 3rd Orbiter (103), September 1983.
Delivery of 4th Orbiter (104). December 1984.
Five flights are scheduled for fiscal year 1983.

Summary of funding levels, fiscal year 1983

Design, development, test and evaluation	
Orbiter	
Main engine	
External tank	
Solid rocket booster	
Launch and landing	
Production	$1,675,500,000
Orbiter	1,023,500,000
Main engine	262,000,000
Launch and landing	67,000,000
Spares and equipment	323,000,000
Changes/systems upgrading	72,500,000
Performance augmentation	60,000,000
Total	1,808,000,000

Design, Development, Test and Evaluation (D.D.T. & E.).—Columbia (Orbiter 102)—the DDT&E flight vehicle—has flown three very successful flights: STS–1 in April 1981, STS–2 in November 1981 and STS–3 in March 1982. STS–1 was the first flight in the four-flight orbital flight test program. The orbiter systems performed almost flawlessly on the first flight. Some minor thermal protection system (TPS) damage was noted, with one whole title and pieces of 15 other titles missing. This minor title damage caused no mission problems. All flight objectives were achieved and the landing took place as planned at Edwards Air Force Base (EAFB).

The second Space Shuttle flight lasted approximately 54 hours, shortened from the planned 124 hours due to a probiem with one of the fuel cells. However, despite the shortened mission, nearly 90 percent of the high priority mission objectives were attained and the flight has been classified as very successful. All systems worked well and only minor anomalies were reported. Title damage was limited to small nicks with no missing titles. Most of the damage was caused by launch and ascent debris. The remote manipulator system's overall performance was excellent. The general status of the vehicle was better than after STS–1. Once again, the crew commented on the precise handling characteristics of the orbiter.

The third launch of Columbia occurred on March 22, 1982. The prelaunch processing demonstrated considerable improvement in the amount of time required to ready the orbiter and the stacked Shuttle vehicle for launch. Instead of the 19 workdays required in the VAB and 34 days on the pad for STS–2, the preparations for STS–3 consumed only 12 days and 30 days, respectively.

In general, the STS–3 mission was quite successful, and revealed the flexibility of the crew and the ground, flight operations and landing operations teams in adjusting to different flight plans. The planned landing at Edwards was changed to the Northrup Strip, New Mexico, at the White Sands Missile Range) with only a few days of notice. Furthermore, the crew and flight operations teams adapted quickly and smoothly to the unacceptable landing conditions at Northrup on the planned seventh and final mission day by extending the mission another day. The Space Shuttle landed the next day.

After the fourth flight, minor modifications will be made to Columbia in preparation for its fifth flight—and the first operational flight of the Space Shuttle in November 1982.

Production.—The Space Shuttle orbiter production program is based on a national fleet of vehicles currently approved as four orbiters. Three orbiter vehicles are now in the production phase: Challenger, Discovery, and Atlantis.

Challenger (Orbiter 099), used in the Design, Development, Test, and Evaluation (DDT&E) program as the structural test article, is being modified to an operational vehicle while Discovery (Orbiter 103), and Atlantis (Orbiter 104) are being manufactured as new vehicles. Columbia (Orbiter 102—the DTT&E vehicle) will be modified to an operational configuration after completion of the orbital flight test program. The prime contractor for the production orbiters is Rockwell International, Shuttle Orbiter Division. The planned delivery schedule for orbiters are: Orbiter 099—June 1982; Orbiter 103—September 1983; and Orbiter 104—December 1984.

The main engine production budget provides for the material procurement, fabrication, and assembly operation necessary to support the orbiter fleet with full power level (EPL) engines. The first production (FPL configuration) engine was assembled in early fiscal year 1982. From materials procurement to final main engine assembly covers a time span of about 42 months. Then another few months are required for shipping to the National Space Technology Laboratories (NSTL), test stand installation, acceptance testing, final checkouts, and inspections before delivery to KSC.

In fiscal year 1983, the materials procurements, fabrication, and assembly operations necessary to support the orbiter production and flight schedule will continue. Residual development activity will also be pursued starting in fiscal year 1983 within the production program. This includes single FPL engine testing, culminating in certification during fiscal year 1983. Subsequent testing will be focused on demonstrating the life capability of the main engine; this effort will demonstrate appropriate maintenance intervals for flight program use, identify components which should be redesigned for longer life, and continue the expansion of the engine certification program to certify the engine for an increased number of missions. Eventually, the main engine is planned to be certified for 55 missions.

An additional launch and landing project will provide for the production and activation of a second line of vehicle processing stations at the Kennedy Space Center (KSC) to support the processing of two or more Space Shuttle vehicles simultaneously. Included in the second line facilities are a second high bay in the Orbiter processing facility

(OPF), a second set of high bays in the Vehicle Assembly Building (VAB), a second mobile launch platform (MLP), a second launch pad, a third firing room in the launch control center (LCC), and a solid rocket motor (SRM) processing facility. A systems engineering effort is required to ensure the orderly activation of facilities and implementation of changes to specifications, drawings, and documentation that have occured during first line activation efforts. The basic facilities exist for the second line high bays in the OPF and BAV, and for the second MLP, second launch pad and third firing room in the LCC. Ground support equipment is being procured and installed in all of these second line processing stations; the OPF, MLP, and VAB second line facilities will all be activated during fiscal year 1982. The firing room is to be activated in fiscal year 1983 and the launch pad is to be activated at the end of fiscal year 1986. Construction of the solid rocket booster processing facility is scheduled to be initiated in fiscal year 1982 and activation is scheduled in fiscal year 1984. The temporary office housing will consist of railroad boxcars and leased trailers which will be obtained, situated, and activated in fiscal year 1982. All of these second line facilities are on schedule to meet the activation dates stated. The thrust of the fiscal year 1983 effort will be to design, install, checkout, and validate the second line of facilities and ground support equipment for the DOD-secure third firing room, the solid rocket motor processing station set and Launch Pad B.

Spares and equipment.—This program element provides for the initial lay-in of spares adequate for replacement of Shuttle components, the tooling requirements for higher external tank and solid rocket booster production rates and the procurement of adequate levels of flight crew equipment.

Sufficient initial spares are being procured to provide support for a flight rate of 13 flights in 1985, with the provision to procure at least one of every functional line replaceable units by that time. Test and turnaround support will also be commensurate with that rate. External tank productivity efforts initiated under the design, development, test and evaluation program in prior years will be pursued in the production program. The goal of this activity is to reduce future external tank costs by identifying productivity improvements in assembly and manufacturing operations. Tooling modifications and additional tools to accommodate a higher hardware production rate will continue at both external tank and solid rocket booster prime contractor and subcontractor facilities.

The production of crew items will result in a space suit inventory of 13 training and 19 flight suits at the end of fiscal year 1983, with all five sizings available. This inventory plus the life support system and related spares will support flight and backup crew needs for training through STS–15 and for flights through STS–14.

Changes and systems upgrading.—Management, technical flight experience, and cost reviews of the Space Shuttle program have stressed the need for providing an adequate allowance for changes and modifications which inevitably are required in a large, complex, and technically demanding space system. The changes and systems upgrading budget represents the estimated requirement for potential changes and systems modifications and unanticipated developments which are not

included in the budget estimates for development and production. Such funds are necessary to provide for programatic and technical changes which result from Space Shuttle development ground and flight testing, and experience in the production phase. Those changes include modification to the orbiters to improve flight performance and system reliability, changes and upgrading of ground systems to reduce turnaround time between missions, and replacement/modification of hardware elements to achieve increased operating economics.

Performance Augmentation.—As Space Shuttle development progressed, some erosion in payload capability and performance margins occurred, primarily as a result of growth in the system's inert weight, particularly in the orbiter. Present projections show that even if planned orbiter weight reduction measures and other system improvements are fully successful, some augmentation of ascent performance will be needed to support certain national security missions. This additional capability will be required to support a scheduled launch from the Western Space and Missile Center in October 1985.

Based upon comprehensive assessments of mission requirements and detailed systems engineering and tradeoff studies of several performance augmentation options, NASA has decided to reduce the inert weight of the solid rocket boosters by using filament wound motor case segments to replace the heavier steel cases. This auugmentation in performance would be available for missions launched from both the east coast and the west coast launch sites. In addition to satisfying the performance requirements of certain national security missions, the availability of the lighter weight filament wound motor case segments for other missions—where performance margins would otherwise require higher performance levels from the main engine and fine tuning of mission plans—is expected to lower the operating and maintenance costs. In order to meet the October 1985 flight availability date, filament wound case design and overall space transportation system integration activities are being intiated in fiscal year 1982.

Committee comment

The Space Shuttle remains the key to a viable space transportation system that is enabling the United States to maintain its leadership in space technology and in the utilization of the space environment to meet national needs. Furthermore, in order to meet the commercial, civilian and national security demand for the Space Shuttle system, the Committee has consistently recognized and supported the need for a Shuttle fleet consisting of at least five orbiters.

Testimony presented at the Committee's hearings has only served to reinforce this view. Additionally, the French launch system, Ariane, recently has been declared operational and the French have embarked on an aggressive marketing strategy with the goal of capturing 30 percent of the market between 1985 and 1991. hey are well on their way to achieving this goal. At the Committee's hearing, the president of Arianespace stated, "As of today 32 satellites are firmly booked (contracts signed) on Ariane for the benefit of 15 customers around the world. In addition, Arianespace has signed launuch reservations agreements with 7 customers for 9 payloads." What is even more startling is that several customers who were signed onto the Space

Shuttle have already switched to Ariane. The president of Arianespace goes on to say that "In our Western world, commercial application in a worldwide launch service market of some $10 billion (in the 1980's only) means competition."

The Committee strongly believes that if we are going to compete we are going to have to have the capacity to meet the growing demand by all sectors. Consequently, the Committee's recommendation included $90 million to begin production of the fifth orbiter.

It is the Committee's understanding that NASA is currently reviewing a proposal for private sector funding of the fifth orbiter. The inclusion of these funds by the Committee are not to be interpreted as to either prejudice or preempt a decision on this proposal. It is expected that accommodations and adjustments can be made should a positive decision be reached on the proposal for private sector purchase of the fifth orbiter. The Committee expects to review any decision by the administration including the terms thereof. In any event, the Committee does feel that a commitment must be made to a fifth orbiter in order to keep the production lines going to avoid increased costs and schedule delays.

On a related matter, the Committee is distressed that the report which was requested by the Committee in its report accompanying the National Aeronautics and Space Administration Authorization Act of 1982 dealing with examining ways to reduce orbiter production costs while still meeting projected national needs has still not been received. The Committee directs NASA to submit that report to the Congress by August 1, 1982.

SPACE FLIGHT OPERATIONS PROGRAM, $1,448,000,000

The Space Flight Operations program includes space transportation systems operations capability development; the common support activities conducted under development, test and mission support (engineering and technical base); advance programs, Spacelab; and space transportation system operations. It includes the activities listed in the following table:

Summary of funding levels, fiscal year 1983

Space transportation systems operations capability development	$235,400,000
Development, test and mission support/engineering and technical base	82,400,000
Advanced programs	11,900,000
Spacelab	113,200,000
Space transportation systems operations	1,005,100,000
Total	1,448,000,000

Space transportation system (STS) operations capability development provides for space transportation system development activities other than the Space Shuttle. These development and support activities are necessary for the orderly transition to STS operations. Principal areas of activity include the STS upper stages, multimission and payload support equipment, Mission Control Center upgrading (Level II), payload and operation support, and STS operation effectiveness.

The STS upper stages proposed by NASA consist of the inertial upper stage (IUS) and the spinning solid upper stage (SSUS). They

are expendable, propulsive stages required to provide the capability to deploy Shuttle-launched payloads to high energy orbits not attainable by the Shuttle alone. Multimission and payload support equipment consists of ground and flight hardware used for interfaces between the payloads and the Space Transportation system, as well as test equipment to verify payload integration compatibility. This class of hardware will be developed into a standard reusable inventory to support a variety of payloads. The Mission Control Center (MCC) upgrading (Level II) is the reconfiguration of the Johnson Space Center Mission Control Center to support the STS operations flight schedule requirements. Level II will provide additional hardware, equipment, and software to upgrade the MCC to provide the capability to support three simultaneous orbiter operations. This effort will continue during fiscal year 1983. The payload and operations support activity consists of two major efforts; orbital flight test (OFT) payload integration and the Payload Operations Control Center (POCC). The orbital flight test payload integration provides for the integration of payloads on the OFT flights. The POCC, to be located at the Johnson Space Center, will provide facilities for command and control of Shuttle/Spacelab attached payloads. Finally, STS operations effectiveness involves developing ways to improve the operational effectiveness and performance of the STS in the following areas: vehicle hardware, vehicle turnaround/cargo processing, system software automation, mission operations, and management procedures.

Performance augmentation will be initiated to improve Shuttle performance capability. Improved performance is necessary for certain missions launched from Vandenberg Air Force Base (VAFB) and to accommodate new payloads and new space utilization concepts.

Development, test, and mission support (DTMS) continues to provide the common engineering scientific and technical support required to conduct space transportation system (STS) research and development at the Johnson Space Center, the Kennedy Space Center, the Marshall Space Flight Center, and the National Space Technology Laboratories. The DTMS effort is focused on four areas: research and testing, data systems and flight activities and operations and launch systems. These activities include engineering support for indepth technical examination of flight hardware and Shuttle related systems. DTMS also provides necessary equipment and supplies and performs alternative design, testing, and analysis in high technology areas of design and development.

The Spacelab is a major element of the space transportation system The program is being carried out jointly by NASA and the European Space Agency (ESA) to provide a versatile, reusable space laboratory which will be flown to and from Earth orbit in the cargo bay of the Shuttle. The Spacelab will consist of a pressurized module and unpressurized pallet segments which can be used in various combinations to support mission requirements. It will permit researchers to conduct a wide range of experiments in a ground-type laboratory while operating in the unique environment of space. Ten European nations, nine of which are members of the European Space Agency, are participating in the program. NASA and ESA are committed to bear the cost of their respective program responsibilities. ESA responsibilities include the design, development, production, and delivery of the first Spacelab,

associated ground support equipment, and the Instrument Pointing System (IPS). NASA funding responsibilities include development of flight and ground support equipment not provided by ESA, development Spacelab operations capabilities, and procurement of additional flight and ground hardware needed to support NASA's Spacelab mission. Fiscal year 1983 funding is required to continue the procurement of the Spacelab follow-on hardware from ESA and to provide for a first flight in September 1983. The procurement includes a second set of flight elements and spares to support early Spacelab flights.

The advanced program effort provides technical as well as programmatic data for the definition and evaluation of potential future space missions and systems. In support of this effort, advanced development activities are conducted to provide a basis for obtaining significant performance reliability improvements and reducing future program risks and development costs through the effective use of new technology.

The advanced programs effort will be focused on conducting system and subsystem development for studies for the definition of space platforms for low and geosynchronous orbits and tether systems; the continued definition of alternative facility concepts to support the permanent presence of man in low Earth orbit; assembly and construction operations for large space systems and structures in orbit; the investigation of systems and subsystems concepts involving satellite services (i.e., placement, retrieval, and on-orbit maintenance and repairs); the definition of advanced transportation vehicle concepts including orbital transfer vehicles and Shuttle-derived launch vehicles; and the definition and analysis of satellite placement and retrieval systems remote from the orbiter. Completion of the alternative systems concept studies for the space platform will be accomplished.

Space transportation system operations will provide the transportation services and operational activities to bring about more effective access to, and utilization of space for the expansion of human knowledge and for practical benefits on Earth. The space transportation system will provide for the delivery of free-flying payloads to low Earth orbit, facilitate the conduct of experiments using the Shuttle orbiter as a carrier vehicle for experiments mounted in Spacelab pressurized modules and on Spacelab pallets in the combined capabilities of the Shuttle and upper stages, retrieve free-fiying payloads from Earth orbit, and provide on-orbit servicing of satellites.

Committee comment

The administration request for Space Flight Operations is $1,707,000,000. The increase from the level of $895 million in fiscal year 1982, results from a change of emphasis from the developmental stage to an operational stage for the Shuttle program. A small amount of funding remains in the Development, Test and Mission Support/Engineering and Technical Base to carry out necessary follow-up development work. The Space Transportation Systems line item has increased by $891,100,000 to reflect the funding requirements for external tanks and solid rocket boosters, as well as the production of flight hardware to support the currently planned flight rate. The budget request also includes funds for procurement of inertial upper stages for NASA launches in later years.

In 1977 the National Aeronautics and Space Administration and the Department of Defense entered into an agreement on how much

the Defense Department would pay for total launch services using the Shuttle. This agreement was based on the Department of Defense's paying its fair share of launch costs with some adjustment for services of equal value performed by each agency for the other. Certain fees were established based on expected flight rates and operational costs of the Shuttle. However, changes in flight manifests, a severe reduction in NASA's planned missions and an unpredictable economy have resulted in a severe imbalance in the conditions on which this fee agreement was based. If continued in its present form, the fee agreement would effectively tax the non-Shuttle related NASA space and aeronautics research and development programs to subsidize Department of Defense flights on the Shuttle.

The Committee's 1983 Authorization bill contains language which states that the Department of Defense shall pay to NASA full costs of placing its payloads into orbit using the Space Shuttle, on a yearly basis, at the same rate that NASA pays for launches of civilian flights, with adjustment for services of equal value. The intent of this language is that NASA will estimate each year the full cost of a Shuttle flight occuring during the next fiscal year and the Defense Department will reimburse NASA for Shuttle flights at this rate in the fiscal year prior to launch of their payloads. Costs will include those for launching, servicing and retrieving Department of Defense payloads. NASA will also estimate any adjustments for services of equal value performed by each agency for the other.

To reflect this policy a reduction of $409 million has been made in the Space Flight Operations line item. This represents the Committee estimate of services performed by NASA for the Department of Defense for Shuttle launches in fiscal year 1984 to be paid to NASA in fiscal year 1983.

The Committee bill contains a net increase of $150 million for development of a centaur high energy upper stage vehicle to be used for NASA's planetary missions (including Galileo and International Solar Polar Mission) and for Department of Defense and commercial requirements during the late 1980's. It is the Committee's belief that a NASA development of the Centaur vehicle is the most cost effective way of meeting all of the needs of the civilian and defense sectors in the most timely way. The inertial upper stage program should be continued for the other purposes to which it was intended including launch of the Tracking and Data Relay Satellites and various defense geosynchronous orbital missions.

The Committee is concerned about a smooth transition from a developmental program for the Space Shuttle to a fully operational system. NASA is a R & D agency and is not intended to be an operational agency. One part of the Committee's concern is that NASA may be basing management decisions primarily on budgetary constraints, rather than the economically optimal way to manage an operational space shuttle system. Consequently, the Committee requests NASA to have their operational plans, cost analyses and pricing policies reviewed by independent financial management experts outsie the agency to examine the proposed operational system and recommend the most ecoonmically optimal alternatives to implement an operational system.

Secondly, in order to obtain better projections of actual operations costs, the Committee directs NASA to delineate more clearly the direct operations costs such as launch, flight and landing services in its budget justification for future years.

The current Office of Space Transportation Systems manages the Space Shuttle production and operations as well as the development of new programs including the possibility of a new initiative for a permanent manned presence in space. The Committee encourages NASA to clearly distinguish those aspects of the Office of Space Transportation systems which deal only with the Space Shuttle from those aspects which deal with future development programs.

EXPENDABLE LAUNCH VEHICLES PROGRAM, $42,800,000

The objective of the Expendable Launch Vehicles program is to provide for the centralized procurement of launch vehicles and launch support services for NASA's automated spacecraft missions, and for other agencies and private organizations utilizing these systems and services on a reinbursable basis.

NASA's expendable launch vehicle transportation system consist of the Scout, the Atlas Centaur, the Delta and the Atlas-F vehicles. This family of launch vehicles has been developed to support NASA's automated spacecraft launch requirements and, on both a cooperative and a reimbursable basis, to support other government, international, and commercial agencies and oragnizations. The expendable launch vehicle program includes the procurement of vehicle hardware, launch services, engineering and maintenance support, including the necessary reliability improvement of the launch vehicle, and the ancillary ground equipment. In fiscal year 1983, all launches of the Scout, Atlas Centaur, and Atlas-F vehicles will be reimbursable.

Launches under this program are conducted from sites located at the Eastern Space and Missile Center (ESMC) formerly called the Eastern Test Range (ETR) in Florida, the Western Space and Missile Center (WSMC) formerly called Western Test Range (WTR) in California, the Wallops Flight Center in Virginia, and the San Marco Platform off the African coast near Kenya.

Funding levels fiscal year 1983

Scout	----------
Centaur	----------
Delta	$42,800,000
Total	52,800,000

The Scout launch vehicle was initiated by NASA in 1959 with the goal of economically launching a wide variety of small scientific satellites, space probes, and re-entry experiments. The first Scout launch occurred in July 1960. In the ensuing 21 years, there have been 102 launches. The Scout vehicle is the smallest launch vehicle employed by NASA. It is a four-stage, solid propellant launch vehicle. The vehicle is approximately 22.4 meters in length (73 feet) and the first stage booster has a diameter of 1.14 meters (3.75 feet). It is capable of placing a 180 kilogram (400 pound) payload in a 556 kilometer (300

nautical mile) orbit. No appropriated funds are required for fiscal year 1983 since the only NASA activity utilizing this vehicle system will be launching of a San Marco Cooperative Mission in 1983. Fiscal year 1982 funds are estimated to be sufficient to support the NASA effort in this cooperative program. However, this vehicle will be used to support DOD launches at least through 1985 on a reimbursable basis.

The Centaur launch vehicle project provides for the procurement and launch of the Atlas booster stage and the Centaur upper stage. The Centaur is a high performance upper stage, which is the most powerful used by NASA for automated missions. It is being used with the Atlas booster for high energy missions to synchronous orbits. The Atlas Centaur vehicle is 40 meters (131 feet) in length and has a diameter of 3.1 meters (10 feet). The first Atlas Centaur launch occurred in 1962. In the ensuing 19 years, there have been 58 launches. No appropriated funds are required for fiscal year 1983 since no NASA space craft are planned to be launched with this vehicle system. However, this vehicle will be used for Intelsat launches at least through 1984, for which NASA will be reimbursed.

The Delta launch vehicle is the most widely used vehicle in NASA's expendable launch vehicle family. Since its first use in 1960, this vehicle has been utilized in 158 launches and has experienced a success record of over 92 percent. It is presently operational with two and three stage configurations. The first stage is an elongated Thor booster with three, six, or nine strap-on solid motors for thrust augmentation. The second stage Delta, which provides a multiple restart capability, uses an inertial guidance system for guiding the first stage booster and the second stage Delta. With the use of a Payload Assist Module (PAM/SSUS–D) solid motor attached to the spacecraft, this vehicle is capable of placing a 1,100 kilogram payload (2,400 pounds) into a synchronous transfer orbit. This vehicle in its three-stage configuration is approximately 35 meters in length (115 feet) and has a diameter of 2.44 meters (8 feet). The fiscal year 1983 funding will be used to continue the Delta launch vehicle procurements initiated in prior years to support Landsat-D and Active Magnetospheric Particle Tracer Explorer NASA spacecraft requirements. Funds are also required for technical and engineering support to sustain vehicle test and checkout and launch operations, and to support maintenance of launch facilities and ground equipment.

PHYSICS AND ASTRONOMY PROGRAM, $491,700,000

The major objective of the Physics and Astronomy program is to increase our knowledge and understanding of the solar-terrestrial environment and of the origin, evolution, structure and composition of the universe, including the Sun, the stars, and the other celestial bodies. Space based research is being conducted to investigate the physics, chemistry and the transport processes occurring in the Earth's magnetosphere, ionosphere, and atmosphere, and the responses of the transport processes to solar phenomena and variability; the structure and dynamics of the Sun and its long- and short-term variations; cosmic ray, X-ray, ultraviolet, optical infrared, and radio emissions from stars, interstellar gas and dust, pulsars, neutron stars, quasars, black holes and other celestial sources; and the laws governing the interactions and processes occurring in the universe. Many of the phenomena

being investigated are not detectable from ground-based observatories because of the absorbing or distorting effects of the Earth's atmosphere.

To achieve the objectives of the Physics and Astronomy program, NASA employs theoretical and laboratory research; aircraft, balloon and sounding rocket flights; Shuttle/Spacelab flights; and free-flying spacecraft. Research teams involved in this program are located at universities, industrial laboratories, NASA field centers, and other Government laboratories. The scientific information obtained and the technology developed in this program are made available to the scientific communities for the application to and the advancement of scientific knowledge, education and technology.

The physics and astronomy missions undertaken to date have been extraordinarily successful. Although the last two of the highly successful High Energy Astronomy Observatories (HEAO's) have ceased operation in the last year, three missions continue to bring us a rich harvest of data—the International Ultraviolet Explorer (IUE), the International Sun-Earth Explorer (ISEE), and the Dynamics Explorer (DE) missions. In addition, the Solar Maximum Mission (SMM), prior to its partial failure in December of 1980 has given us a new picture of the sequence of events that occur in a flare of the Sun; it also measured nuclear processes that accompany these energetic events. After observing a large number of flares, data from the Solar Maximum Mission have contributed significantly to the development of a new model of how solar flares occur.

Summary of funding levels, fiscal year 1983

Space telescope development	$137,500,000
International Solar Polar Mission development	21,000,000
Gamma Ray Observatory development	34,500,000
Shuttle/Spacelab payload development and mission management	81,400,000
Explorer development	39,300,000
Mission operations and data analysis	93,600,000
Research and analysis	45,200,000
Suborbital programs	39,200,000
Total	491,700,000

Launch schedule

Project and mission:	Year
Space Telescope (ST)	1985
International Solar Polar Mission (ISPM) (ESA spacecraft only)	1986
Gamma Ray Observatory	1988
Spacelab:	
Spacelab–1	1983
Spacelab–2	1984
Space Shuttle orbital flight test payloads: OSS–3	1985
Explorers:	
San Marco-D/low orbit	1982
Infrared astronomy satellite	1982
Cosmic ray isotope experiment	1982
Active magnetospheric particle tracer explorer	1984
Cosmic background explorer	1987
Extereme ultraviolet explorer	1988
Suborbital programs:	
Sounding rockets—About 50 launches per year.	
Balloon flighes—About 20 launches per year.	
Airborne—About 65 flights per year of Kuiper Airborne Observatory.	

NOTE: Shuttle/Spacelab payloads in support of space science objectives will build to a flight rate of approximately 2.5 equivalent Spacelab missions per year by 1985.

The Space Telescope will make a major contribution to understanding the stars and galaxies, the nature and behavior of the gas and dust between them, and the broad question of the origin and scale of the universe. Operating in space above the atmospheric veil surrounding the Earth, the Space Telescope will increase by several hundredfold the volume of space accessible for observations. With its significant improvements in resolution and precision in light sensitivity and in wavelength coverage, the Space Telescope will permit scientists to conduct investigations that could never be carried out using ground-based observatories due to the obscuring and distorting effects of the Earth's atmosphere. The Space Telescope will enhance the ability of astronomers to study radiation in the visible and ultraviolet regions of the spectrum. It will be more sensitive than ground-based telescopes and will record greater detail about the objects under study. It will make possible observation of objects so remote that the light will have taken many billions of years to reach the Earth. As a result, we will be able to look far into the distant past of our universe. The Space Telescope will also contribute significantly to the study of the early state of stars and the formation of solar systems, as well as to the observation of such highly-evolved objects as supernova remnants and white dwarf stars. With the Space Telescope, we may be able to determine the nature of quasars and the processes by which they emit such enormous amounts of energy, and it may also be possible to determine whether some nearby stars have planetary systems. The Space Telescope will be an automated observatory, delivered into orbit by the Space Shuttle. Data from its scientific instruments will be transmitted to Earth via the Tracking and Data Relay Satellite System. The Space Telescope design will permit in-orbit maintenance, repair, and retrieval by the Space Shuttle for return to Earth, refurbishment, and reuse.

Launch of the Space Telescope is still scheduled for January 1985 on STS–23. The fiscal year 1982 funding will continue to cover the fabrication of the telescope with complete assembly of it expected in early fiscal year 1984. Detailed design, development and manufacture of the optical telescope assembly, the support systems module and the scientific instruments is occurring during 1982. Assembly of the optical telescope assembly subsystems will continue and assembly and test of the scientific instruments will be initiated. The critical design review for the support systems module will take place and manufacturing will begin.

The International Solar Polar Mission is a joint NASA and European Space Agency (ESA) mission designed to obtain the first view of the solar system from a new perspective—a view from far above the plane in which the planets orbit the Sun's equator. The mission will aid in the study of the relationship between the Sun and its magnetic field and particle emissions (solar wind and cosmic rays) as a function of solar latitude, and hence allow us to gain insight into the effects of solar activity on the Earth's weather and climate. In fiscal year 1981, restructuring of the International Solar Polar Mission program to a single-spacecraft mission was implemented. Although the United States is no longer developing a spacecraft for this mission, U.S. participation remains substantial. Of the nine investigations to fly

on the remaining European spacecraft, five have U.S. principal investigators and three or the four European investigations have U.S. co-investigators.

The objective of the Gamma Ray Observatory mission is to measure gamma ray radiation from the universe and, thus, to explore the fundamental physical processes powering it. Certain celestial phenomena are accessible only at gamma ray energies. The observational objectives of the Gamma Ray Observatory are to reach for direct evidence of the synthesis of the chemical elements; to observe high energy astrophysical processes occurring in supernovae, neutron stars and black holes; to locate gamma ray burst sources; to measure the diffuse gamma ray radiation for cosmological evidence of its origin; and to search for unique gamma ray emitting objects. Gamma rays represent one of the last frontiers of the electromagnetic spectrum to be explored because the required technology has only recently been developed. The low flux levels of gamma ray quanta, and the high background they produce through their interaction with the Earth's atmosphere, coupled with the demand for better spectral, spatial, and temporal resolution of source features, combine to require that large gamma ray instruments be flown in space for a prolonged period. Gamma rays provide unique information on the most intriguing astronomical objects yet discovered, including quasars, neutron stars, and black holes. Astronomy is now to the point where our understanding of these objects is being seriously impaired by lack of data in the gamma ray region of the spectrum. Comprehensive research in gamma ray astronomy has consistently been given high priority by the science community. The Gamma Ray Observatory will be launched by the Space Shuttle. The spacecraft is designed to accommodate several gamma ray instruments. It is planned that the instruments will have their principal axis pointing in the same direction, and the spacecraft will point these instruments in a fixed direction in space for long periods (hours to weeks).

After a 2-year deferral of its hardware phase, GRO will begin development of spacecraft and instrument hardware during fiscal year 1983.

The objectives of Shuttle/Spacelab payload development and mission management are to acquire new knowledge in the disciplines of physics and astronomy and to manage the mission planning and execution of the complete NASA Spacelab payload program. The funding provides for the development of all physics and astronomy Spacelab experiments, the system management and engineering development of the flight equipment and software, the payload specialist support, the physical integration of the payload with the Spacelab system, the operation of the payload during flight, the dissemination of data to experimenters, and the analysis of physics and astronomy flight data. Instruments to be flown on three missions primarily dedicated to physics and astronomy science are now under development. The OSS–1 pallet was flown on the STS–3 in 1982. The OSS–1 mission consisted of six instruments that gathered solar physics data, evaluated the Shuttle environment, and provided data on thermal control technology.

Spacelab-1, which will consist of a pressurized Spacelab module and a pallet, is scheduled for flight in 1983. The objectives of Spacelab-1

are to demonstrate the capabilities of the Spacelab system and to obtain multidisciplinary scientific data with emphasis on atmospheric and space plasma physics. In 1982, the Spacelab-1 payload will be integrated with the Spacelab equipment. Spacelab-2, an all-pallet configuration, is scheduled to fly in 1984. The objectives of Spacelab-2 are to verify the Spacelab igloo and pallet systems and to obtain scientific data, with emphasis on astrophysics and solar physics. The instrument pointing system, developed by the European Space Agency, will be used for the first time on the Spacelab-2 mission. During fiscal year 1982, Spacelab-2 mission management activities and instrument development will continue. The OSS–3 mission is also under development leading to a launch scheduled for 1985. OSS–3 is a Spacelab pallet payload of three ultraviolet telescopes that will carry out ultraviolet imaging, spectrophotometry and polarimetry at resolutions and sensitivities previously unavailable. This payload will allow unique new scientific investigations of a broad range of objects from nearby comets and planets out to the most distant quasars. Data gathered by the OSS–3 mission will be used to define and direct future Space Telescope observations. The OSS–3 science instruments will be reflown on the Shuttle during the period of Halley's Comet for unique scientific observations of the comet from the near-Earth orbital environment.

In fiscal year 1983, mission management of the ongoing NASA Shuttle/Spacelab missions will continue. Mission management for the nonphysics and astronomy missions involves all the Spacelab payload functions except instrument or experiment development and data analysis. Included among the activities outside the physics and astronomy disciplines are mission management for the space applications, technology and life sciences program. The fiscal year 1983 funding is also required for analysis of data from the OSS–1 flight. Efforts will be completed on Spacelab–1 leading to a launch in 1983. Spacelab–2 integration and test activities will be continued in fiscal year 1983 leading to a launch in 1984. Instrument development for the OSS–3 flight will be continued as well as development efforts on the Solar Optical Telescope.

The fiscal year 1983 budget request will allow continued mission management of ongoing NASA Shuttle/Spacelab missions including instrument development for Physics and Astronomy missions and Spacelab payload functions for nonphysics and astronomy missions in the life sciences, space applications and technology programs. Fiscal year 1983 funding will also support data analysis from the OSS–1 flight. Instrument development for the OSS–3 flight will be continued as well as development efforts on the Solar Optical Telescope.

The explorer program provides the principal means of conducting astronomical studies and long-term investigations of solar physics and of the near-Earth interplanetary environment having limited, specific objectives and not requiring major observatories. Included in the present program are missions to study atmospheric and magnetospheric physics; the several magnetospheric boundaries; interplanetary phenomena; and X-ray, ultraviolet, and infrared astronomy. Studies are conducted to define future high priority science explorer missions. NASA engages in cooperative missions with other Federal agencies

and other nations whenever such cooperation will assist in achieving NASA objectives. Solar terrestrial and atmospheric explorers provide the means for conducting studies of the Earth's near-space environment. The program requires a wide variety of satellites in orbits extending from the very lowest reaches of the upper atmosphere, to the interplanetary medium beyond the Earth's magnetosphere. Efforts in fiscal year 1982 include completion of development activity for the San Marco-D (low orbit) mission and continuation of development on the Active Magnetospheric particle Tracer Explorer. The San Marco–D mission, a cooperative project with Italy, will include a group of U.S. experiments to study the relationship between solar activity and the Earth's meteorological phenomena.

The Active Magnetospheric Particle Tracer Explorer, a cooperative project with the Republic of Germany, will involve the use of two spacecraft, one designed and built in the United States, to study the solar wind at the subsolar point and to identify particle entry windows, energization processes and transport processes into the magnetosphere. The two Dynamics Explorer spacecraft, launched in August 1981, are already providing valuable data on interactive processes of the magnetosphere, ionosphere, and upper atmosphere. The Solar Mesosphere Explorer, launched in October 1981, is investigating the global distribution and production of atmospheric ozone, and variability in solar ultraviolet radiation. Astrophysics explorers have been instrumental in conducting the first astronomical sky surveys in the gamma ray, X-ray, ultraviolet, and low-frequency radio regions of the electromagnetic spectrum. A major effort underway in fiscal year 1982 is the completion of satellite integration and testing activities on the Infrared Astronomical Satellite, which is scheduled to be launched in late 1982. This satellite is expected to record precise flux levels and locations of over a million infrared sources in the universe. A smaller development effort which is nearing completion is the Cosmic Ray Isotope Experiment. This payload, which will be launched in 1982 on a Department of Defense spacecraft, will be used to study galactic cosmic rays, as well as nuclei accelerated from solar flares, in order to shed light on models of nucleosynthesis and to identify probable sources of cosmic ray nuclei. In addition, development will begin in late fiscal year 1982 on the Cosmic Background Explorer (COBE). COBE will carry out a definitive all-sky exploration of the diffuse cosmic background radiation of the universe between the wavelengths of 1 micrometer and 13 millimeters. The detailed information this mission will provide on the spectral and spatial distribution of low energy background radiation is expected to yield significant insights into basic cosmological questions of the origin and evolution of the universe.

Fiscal year 1983 explorer funding will provide for continued development activity on the AMPTE and COBE missions. Fiscal year 1983 funding will also provide for design and definition studies for future candidate missions, including the Extreme Ultraviolet Explorer and the X-ray Timing Explorer. The Extreme Ultraviolet explorer, the next candidate Explorer mission, is approaching readiness for a development start. This mission will carry out the first detailed all-sky survey of ultraviolet radiation between 100 and 900 ang-

stroms—a hitherto unexplored portion of the electromagnetic spectrum.

The purpose of the mission operations and data analysis effort is to conduct operations and to analyze data from the physics and astronomy satellites after launch. This program also supports the continued operation of a number of spacecraft, after their originally planned objectives have been achieved, for purposes of conducting specific investigations that have continuing, high scientific significance. The funding supports the data analysis activities of the many investigators at universities and other research organizations associated with astrophysics and solar terrestrial operational satellite projects. Actual satellite operation, including operation control centers and related data reduction and engineering support activities are typically carried out under a variety of mission support or center support contracts. Several explorer spacecraft remain operational and are providing valuable data. The International Ultraviolet Explorer and International Sun-Earth Explorers continue to perform well, with very productive guest investigator programs. Mission operations and data analysis will continue for these missions through fiscal year 1982, as well as for the recently launched Dynamics Explorer and Solar Mesophere Explorer spacecraft. In addition to the normal support required for mission operations, the Space Telescope program encompasses several unique aspects which must be provided for well in advance of launch. The Space Telescope is designed for operation for more than a decade, based on in-orbit maintenance, recovery, refurbishment, and relaunch and in-orbit changeout of the scientific instruments. During the operational period, the Space Telescope will be used primarily by observers selected on the basis of proposals submitted in response to periodic solicitations. NASA has determined that the most efficient and scientifically satisfactory approach to science operations will involve establishment of an independent Science Institute which will operate under a long-term contract with NASA. While NASA will retain operational responsibilities for the observatory, the institute will implement NASA policies in the areas of planning, management, and scheduling of the scientific operations of the Space Telescope.

Fiscal year 1983 funds will provide support for the basic mission operations and data analysis activities for the Dynamics Explorers, the Solar Mesosphere Explorer, and the Infrared Astronomical Satellite; data analysis activity for the Cosmic Ray Isotope Experiment which is scheduled for launch on an Air Force spacecraft in 1982; extension of operations and data analysis activity for the International Ultraviolet Explorer, the International Sun-Earth Explorers-1, -2, and -3; and support for continued analysis of the extensive data obtained by the High Energy Astronomy Observatory missions. Fiscal year 1983 funding will also support the continued operation and data analysis activities of the Solar Maximum Mission (SMM), including the planned retrieval/repair of the partially disabled SMM spacecraft and instruments as well as the continuation of preparations for science operations of the Space Telescope, including development of the Space Telescope Institute and the science operations ground system. The fiscal year 1983 funding is also required for initiation of design and fabrication of support equipment and orbital replacement units to be used for Space Telescope maintenance and refurbishment.

The research and analysis program provides for the research and technology base necessary to define, plan, and support flight projects. Preliminary studies to define missions and/or payload requirements are carried out as are theoretical and ground based supporting research and advanced technology development (ATD). Activities included are supporting research and technology (SR&T), ATD and data analysis.

The suborbital program provides versatile, relatively low cost research tools that complement the capabilities of balloons, aircraft, free-flying spacecraft and the Space Shuttle in all the space science disciplines, including the study of the Earth's ionosphere and magnetosphere, space plasma physics, stellar astronomy, solar astronomy, and high energy astrophysics. Activities are conducted on both a domestic and international cooperative basis.

Committee comment

NASA requested $471,700,000 for Physics and Astronomy programs in fiscal year 1983. The Committee is concerned about basic support for university research and for support for data reduction from existing and recent successful spacecraft, such as HEAO and OAO. In addition, the Committee is concerned with the slow down in new starts in the Explorer program caused by erosion in budgets and the slow progress in the future programs and basic technology areas which support new spacecraft starts. The Committee increased the total for Physics and Astronomy by $20 million in fiscal year 1983 to be allocated among the following areas: $5 million for Explorer development, $8 million for Mission Operations and Data Analysis, $6 million for Research and Analysis, and $1 million for the Suborbital program.

The Committee approved the reprograming for the Solar Maximum Repair/Retrieval Mission.

PLANETARY EXPLORATION, $194,600,000

The Planetary Exploration program includes the scientific exploration of the planets and their satellites, comets and asteroids, and the interplanetary medium. The program objectives are to understand the origin and evolution of the solar system, to understand better the Earth through comparative studies with the other planets, and to understand how the appearance of life in the solar system is related to the chemical history of the system. The projects undertaken in the past have been highly successful. The strategy that has been adopted calls for a balanced emphasis on the terrestrial-like inner planets, the giant gaseous outer planets, and the small bodies (comets and asteroids). Missions to these planetary bodies start at the level of reconnaissance and exploration to achieve the most fundamental characterization of the bodies, and proceed to a level of detailed study. The reconnaissance phase of inner planet exploration began in the 1960's and has now been completed, though we still know little about the nature of the Venus surface. Mars has provided program focus because of its potential as a site of biological activity.

The Viking landings in 1976 carried the exploration of this planet forward to a new level of scientific and technological achievement, thereby setting the stage for the next step of detailed study. Analyses of the Moon rock samples returned by Apollo continue to be highly

productive as new insights into the early history of the inner solar system are achieved and as our theoretical concepts are revised accordingly. The continuing Pioneer Venus mission is carrying the study of our nearest neighbor, and closest planetary analogue, beyond the reconnaissance stage to the point where we have made a basic characterization of the massive cloud-covered atmosphere of Venus. This characterization has also provided some fundamental data about the formation of the planet. The exploration of the giant outer planets began relatively recently with the Pioneer-10 and 11 flybys of Jupiter in 1973 and 1974. These simple reconnaissance spacecraft returned excellent data which contributed much to the later successes of the Voyager-1 and 2 spacecraft. Voyager-1 encountered Jupiter in March 1979 and Saturn in November 1980. Voyager-2 flew by Jupiter in July 1979, and then Saturn in August 1981. Our scientific knowledge of this part of the solar system has increased greatly in less than a decade. New data on the planets, satellites, and rings have revolutionized our concepts of the formation and evolution of the solar system. Now, the Pioneer-10 and 11 and Voyager-1 spacecraft are on escape trajectories from the solar system as they continue to monitor their uncharted environments. The Voyager-2 spacecraft is headed for an encounter with Uranus in 1986.

Summary of funding levels, fiscal year 1983

Galileo development	$92,600,000
Mission operations and data analysis	41,500,000
Research and analysis	60,500,000
Total	194,600,000

The Galileo mission is a cooperative effort between the United States and the Federal Republic of Germany designed to conduct direct and long-duration studies of Jupiter. The objectives of this program is to conduct a comprehensive exploration of Jupiter its atmosphere, magnetosphere and satellites, through a new deep space spacecraft concept which combines both remote sensing and direct measurements by an orbiter and an atmospheric probe.

The Galileo mission will utilize a single Space Shuttle launch in 1986 for the Galileo orbiter and probe. The orbiter and probe boosted with a Centaur upper stage will conduct a 20 month investigation of Jupiter, its satellites and magnetosphere. Eleven encounters with satellites of Jupiter are planned during the tour. The probe will penetrate the atmosphere of Jupiter to conduct scientific investigations down to a depth where the pressure is equivalent to 10 times the pressure exerted by the Earth's atmosphere, and the orbiter will relay information gathered back to Earth.

The mission operations and data analysis program funds the operation phase of planetary missions after development, launch, and initial in-flight check out is complete. It also provides for multimission flight support. Currently active planetary missions being supported with mission operations and data analysis are Voyagers 1 and 2, Pioneer-Venus, and Pioneer 6–11. It is NASA's plan to terminate operations of the Pioneer spacecraft in January 1983. The Voyager-1 post-Saturn encounter mission operations and the Voyager-2 cruise to Uranus will be continued.

Since their launches in 1977, the two Voyager spacecraft have encountered both the Jupiter and Saturn systems and achieved all of their original objectives. Voyager-1 is now on a cruise trajectory which will take it out of the solar system at a steep angle to the plane of the ecliptic. The spacecraft will collect data on the space environment as it proceeds to the outer limits of our solar system. Voyager-2 successfully flew near Saturn in August 1981 and was placed on a trajectory which will take it to an encounter with the planet Uranus in January 1986.

The research and analysis program contains five elements required to assure that data and samples returned from flight missions are fully exploited; undertaking complementary laboratory and theoretical efforts; defining science rationale and development of required technology to undertake future planetary missions; coordinating an International Halley's Comet Watch, providing co-investigator support to the European Space Agency's Giotto Mission to Halley's Comet; and for a proportional share and occupancy of the mid-level facility for visiting astronomers at the Infrared Telescope facilities on Mauna Kea, Hawaii.

Committee comment

During the past decade the planetary missions have kept our national space efforts visible, providing the world with a reminder of our scientific and technological capabilities and strength. The basic research involved with understanding the nature of our solar system and the formation and interaction of the planets are key elements to understanding the interaction between the Earth and the Sun. Understanding this interaction is vital to our understanding of weather and climatic changes. The technology base that has been developed to perform planetary missions has both direct and indirect impact on national security. Finally the Soviets, Japanese and Europeans all have begun solar system exploration programs in recognition of the value of these achievements to their overall space activity.

The NASA request for planetary exploration is $154,600,000. The Committee is particularly concerned about the funding levels for Mission Operations and Data Analysis and Research and Analysis included in planetary exploration. These activities support the operations of the spacecraft and the analysis of the information obtained from these missions. The fiscal year 1983 budget request would have terminated a number of currently operating spacecraft, still capable of transmitting valuable data. This action would reduce severely the complimentary laboratory and theoretical efforts to analyze the data. In 2 years the funding levels for mission operations and data analysis and research and analysis have been reduced by over 50 percent.

The Committee strongly believes that the research being conducted as a result of our past investments in planetary space craft is vital to our on-going solar system exploration program. Paraicularly in light of the fact that now new flight programs have been started since 1978, it is critical that a strong basic research base is maintained. Consequently, the Committee augmented the mission operations program budget by $15 million and the research and analysis budget by $25 million to maintain a constant level of effort in these areas.

The additional funds support continued operations of the Pioneer 6–9 spacecraft, Pioneer 10 and 11, Pioneer Venus, the Lunar Curatorial Facility and the Infrared Telescope Facility.

The Committee understands that efforts are underway to examine the future of the planetary program, and encourages this activity. At the same time the Committee expects NASA to prevent a more severe erosion of this valuable scientific and technological resource.

LIFE SCIENCES PROGRAM, $55,700,000

The goals of the Life Sciences program are to provide a sound scientific, medical, and technical basis for safe and effective manned space flight and to understand the basic mechanisms of biological processes using the unique capabilities of the space program. Results from the research program are applied the immediate needs in the maintenance and health of the astronauts; to the design of future support systems for the astronauts; to understanding the response of biological systems to weightlessness; to the design of controlled life support systems for use in future missions; and to the understanding of the larger scale system—the biosphere of the planet Earth. In the longer term, this program is the key to developing a capability to sustain a permanent manned presence in space. The program includes both ground-based and space research which are mutually supportive and integrated. The program uses a composite of disciplines and techniques in both biology and medicine to address space-related medical problems and fundamental biological processes.

The life science flight experiments project is directed toward understanding the basic mechanisms and time histories of biological and medical processes as they occur in zero gravity. The project includes the whole process of experimental design, development, in-flight execution, data analysis and reporting.

Current activities included the development and fabrication of life sciences flights experiments for early Shuttle flights (e.g., Spacelab–1, Spacelab–2, Spacelab–3 and Spacelab–4). Spacelab–4. is the first flight dedicated entirely to life sciences investigations.

Summary of funding levels, fiscal year 1983

Life sciences flights experiments	$24,000,000
Research and analysis	31,700,000
Total	55,700,000

The research and analysis activity of the Life Sciences program supports ground-based research in biological and biomedical problem areas that have been identified in previous flights or have been determined to be highly probable in future flights. The program is composed of five elements: (1) operational medicine, (2) biomedical research, (3) space biology, (4) terrestrial biology, (5) life support systems research. The operational medicine element is the catalyst responsible for bringing the science, technology, and practice of medicine to bear on sustaining, supporting and protecting the individual working in the space environment. Biomedical research develops the basic medical knowledge needed to enable men and women to operate more effectively in space; it is organized into discreet elements with each de-

signed primarily to rectify a particular physiological problem expected to affect the human organism in prolonged or repetitive spaceflight. Space biology explores the role of gravity in life processes and uses gravity as an environmental tool to investigate fundamental biological questions; for example, investigation and identification of the role of gravity in plant and cellular animal processes or embryonic development. Terrestrial biology includes the study of the origin, evolution, and distribution of life and life-related molecules on Earth and beyond. Sophisticated analyses of life as we know it afford a unique opportunity to address a most fundamental question regarding the origin of life on Earth and the existence of such processes elsewhere. Life support systems will focus on the continuing research and development efforts needed to increase and enhance our ability to support long duration manned space occupancy and maximize astronaut and passenger-scientist productivity.

Committee comment

The Committee continues to believe that the Life Sciences program is of extreme importance in supporting this Nation's progress in utilizing the space environment. The activities in this area contribute to the development of both technology to support man-in-space and an understanding of the health effects of zero-gravity. The successful first flights of the Space Shuttle provide for an optimistic future of the manned program. The Committee is pleased to see a sizable increase in the Life Sciences budget after several years at nearly constant levels and expect to see the activity continue at a sufficient funding level to support NASA's long term goals in space.

SPACE APPLICATIONS, $336,300,000

The objective of the Space Applications program is to conduct research and development activities that demonstrate space-related technology, systems, and other capabilities which provide down-to-Earth practical benefits. These activities are grouped in the following general areas: resources observations, environmental observations, applications systems, technology transfer, materials processing in space, and communications and information systems. In each of these areas, programs are being planned and conducted to contribute to the solution of pressing national, as well as international, problems and needs. Their funding and flight schedules are shown in the tables following:

Summary of funding levels, fiscal year 1983

Resource observations	$132,200,000
Environmental observations	128,900,000
Applications systems	11,700,000
Technology transfer	----------
Materials processing in space	23,600,000
Communications and information systems	39,900,000
Total	336,300,000

The broad objectives of the resource observation program are to develop and apply space observation techniques to meet national and global needs for improved management of food, fiber, water, and land resources; improve our ability to systematically evaluate the composi-

FLIGHT SCHEDULE

Project	Mission	Calendar year
Resource observation:		
Earth resources technology satellites	Launch of Landsat-D	1982.
Shuttle/Spacelab payload development	Orbital flight test missions	1981.
	Spacelabe payloads	Beginning in 1984.
Environmental observations:		
Earth Radiation budget Experiment	Launch of ERBS	1984.[1]
	ERBE instrument to be launched on NOAA F. & G.	1983 and 1985 [1] (subject to NOAA call-up).
Materials processing in space:		
Materials Experiment Operations	Sounding Rocket Flights	1 flight in 1983.
	Flight of Shuttle mid-deck experiments	Beginning in 1982.
Space communications:		
Search and rescue mission	Instruments to be launched on NOAA-E, F, G, H, I and J spacecraft.	1982, 1984–88 (subject to NOAA call-up).
Reimbursable missions:		
GOES [2]	Launch of GOES F–I	1983–86.[1]
NOAA [2]	Launch of NOAA D–J	1982–88.[1] (subject to NOAA call-up).

[1] Currently under review.
[2] National Oceanic and Atmospheric Administration (NOAA) funded.

tion and geometry of the Earth's crust in order to increase the effectiveness of global assessment, exploration, and development of mineral and energy resources; and increase our understanding of the solid Earth, its interior structure and composition, its rotational dynamics, the processes related to the movement and deformation of its crust, and the mechanisms associated with the occurrence of earthquakes. Principal elements of the program include the development of space and supporting ground systems and improved data processing and analysis techniques; Shuttle and aircraft support for sensor and technique development; as well as basic and applied research for identifying, monitoring, analyzing, and modeling the vegetated and geological features of the Earth.

Landsat-D development is proceeding with the launch of Landsat-D planned for July 1982. Landsat-D will incorporate both the Thematic Mapper (TM) and the Multispectral Scanner (MSS). The backup spacecraft D′, will be available for launch 12–15 months later. In addition to continuing the availability of MSS data, Landsat-D will provide imagery with the improved spectral and spatial resolution of the thematic mapper. This is needed to expand the use of space data for agricultural, water resources, land use, and other applications. Another aspect of the resource observation program is the research associated with understanding the physical relationship of various types of vegetation and other surface features with the radiation which they emit or reflect; the development of models appropriate to the management of resources; and the evaluation of the use of space-derived data along with other data sources in meeting user needs. The scope of these activities ranges from individual scientific studies to projects such as the Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing (AgRISTARS).

AgRISTARS, a research, development and test program, addresses identified U.S. Department of Agriculture information requirements

by combining NASA's unique remote sensing development expertise with complementary resources from the Department of Agriculture and Department of Commerce. This program has become the focal point of remote sensing research for application to global vegetation assessments, both within the involved Federal agencies and by the scientific community in general.

The focus of the Multispectral Linear Array (MLA) advanced technology development is on the development of technology for a future high performance MLA instrument for use as a diagnostic tool for fundamental research in remote sensing. The MLA solid state sensor has a number of significant advantages over existing mechanically scanned sensors including electronic scan, inherent geometric and spectral registration and programable high spatial and spectral resolution. The critical technology development and support research initiated in fiscal year 1981 on the linear array instrument and the Shuttle Imaging Spectrometer will continue in fiscal year 1982 and fiscal year 1983.

In renewable resources, the fiscal year 1983 funding will support continuation of research in land resources remote sensing technique development, fundamental remote sensing investigations, processing technique development, and sensor and mission studies. Planned nonrenewable resources research will extend into other portions of the electromagnetic spectrum concentrating on the thermal infrared and microwave regions. Measurement capabilities from aircraft platforms will be expanded and upgraded with the development of digital data recording systems for airborne radars; the six-channel multiband thermal infrared scanner will be tested from an aircraft platform. Experimental remote sensing data collected during the second orbital test flight of the Space Shuttle (i.e., shortwave infrared and radar measurements) will be analyzed in detail. The Magsat principal investigators program will be completed in fiscal year 1982 and a set of global magnetic field maps derived from these data will be published in fiscal year 1983.

In fiscal year 1983 seven new thematic mapper simulated-based technique tests will be initiated dealing with delineation of hydrologic features, modeling of wetlands productive capacity, site selection of facilities for waste disposal, siting of transmission line corridors, assessing crop conditions, and timber inventoring.

NASA's environmental observations program has the goals of improving the understanding of processes in the atmosphere and the oceans, providing space observations of parameters involved in these processes and extending the national capabilities to predict environmental phenomena and their interaction with human activities. Because many of these phenomena are global or regional, they can be most effectively, and sometimes solely, studied from space. NASA's program includes scientific research efforts plus the development of new technology for global and synoptic measurements. NASA's research satellites provide a unique view of the radiative, chemical, and dynamic processes occurring in the atmosphere and oceans.

The Upper Atmospheric Research Satellite Experiments (UARSE) activity initiated in fiscal year 1982 will provide a set of satellite instruments capable of making a comprehensive measure-

ment of the state of the stratosphere. Detailed definition studies of 16 instruments have been completed and a final determination has been made to proceed with development of 9 of these instruments.

The Earth Radiation Budget Experiment (ERBE) mission is proceeding on schedule toward a 1984 launch date with a Critical Design Review planned for early 1982. The flight of the Halogen Occultation Experiment (HALOE) instrument has been removed from the ERBE mission and has been selected as a UARS experiment. NASA has continued to support the National Oceanic and Atmospheric Administration (NOAA) by managing the development of the NOAA and the Geostationary Operational Environmental Satellites (GOES) series on a reimbursable basis. NOAA–C and GOES–E were launched in 1981 and preparations are proceeding to launch NOAA–E in mid-1982.

The airborne instrumentation research program provides flight support to major segments of the space applications program. The aircraft fleet presently consists of two U–2C's, one ER–2, one C–130, and one CV–990. These aircraft serve as test beds for newly developed instrumentation and permit the demonstration of new sensor concepts prior to their flight on satellites. The data acquired during the flights is used to refine algorithms and develop ground data handling techniques and preliminary proof of concept studies. Examples of such activities are flights over test sites to obtain crop signature data for the AgRISTARS program by the C–130 and flights in the ER–2/U–2C's to acquire simulated thematic mapper data. A principal use of the ER–2/U–2C's is to acquire stratospheric air samples and conduct in situ measurements at altitude ranges above the capability of more conventional aircraft and below that of orbiting spacecraft. This use is important in the environmental observation program where much interest exists regarding stratospheric transport mechanisms and where it is extremely desirable to penetrate the stratospheric region, which, in the tropical interconvergence zone, is normally found at altitudes of 60,000 feet and above. Fiscal year 1983 funds are required to provide the necessary aircraft operations support required by the space applications program.

The technology transfer program provides for the development, experimental test and evaluation, and transfer of remote sensing technology applications for operational use by public and private organizations. User requirements and supporting activities have maintained communications at the national level between NASA and the user community to determine and analyze national priorities and user needs, inform users of existing and planned technological capabilities, obtain external evaluations of technology transfer programs for planning purposes, and develop program awareness and technical capabilities in educational institutions. Cooperative efforts have been conducted with State and local governments to evaluate proven Landsat applications in natural resource and environmental management.

The materials processing in space program emphasizes the fundamental science and technology of processing materials in space. This will lead to an understanding of the constraints imposed by Earth's gravitational forces and the unique capabilities made possible by controlling these processes in the space environment. Ground-based research, technology development, and payload definition activities

concentrate on three major processing areas: crystal growth and solidification, containerless processing, and fluid and chemical processing. Limited research is supported in the areas of cloud physics, combustion science, vacuum science, and fluid dynamics. These activities provide the scientific basis for future space applications of materials processing technology. Definition study activities are performed for Shuttle payload candidates such as the acoustic containerless experiments system, the combustion science system, the containerless measurement system, and the floating zone experiment system. The Shuttle/Spacelab payload development project provides opportunities to perform materials science experiments in an extended, microgravity environment.

Materials experiment operations is a consolidation of ongoing activities which provide a range of experimental capabilities for all scientific and commercial participants in the materials processing in space program. These include drop towers and aircraft and sounding rocket flights as well as the Shuttle middeck experiments and the material experiment assembly. These capabilities will enable users to develop experiments in a cost effective manner and allow NASA to develop a better understanding of the technical risks associated with experiment concepts before attempting to develop more complex hardware. In addition, limited reflight of currently selected investigations on sounding rockets and on Shuttle/Spacelab missions is included in materials experiment operations.

The communications program provides the technology that allows the most effective use of the geosynchronous orbit and radio frequency spectrum. A major portion of the program resources are currently concentrated in the applied research and data analysis element of the program which is focused on new communications subsystem technology. In fiscal year 1980, multiyear contracts were placed with industry to develop a technology base in advanced communications for the 1990's. These initial efforts, which will be completed in fiscal year 1983, will produce laboratory models of multibeam atennas, onboard switching, signal processing, and radio frequency components.

The search and rescue program uses satellites to aid in the detection and location of distress beacons carried by aircraft and ships. The search and rescue demonstration and evaluation phase will begin in 1982 with the launch of the first U.S. spacecraft in the series, NOAA–E, and the Soviet satellite COSPAS–1. The search and rescue antennas, receivers, signal processor and transmitter were integrated and tested, completing all necessary preparations for launch. In fiscal year 1982, the ground station development will be completed. Three ground stations will be installed at search and rescue facilities operated by the U.S. Coast Guard and the U.S. Air Force. Experimental distress transmitters operating at 406 MHz will be completed and deployed in accordance with the demonstration and evaluation plan. This work will be done in cooperation with Canada, France, and the U.S.S.R. The search and rescue program is now planned to include payloads aboard six meteorological spacecraft operated by the National Oceanic and Atmosphere Administration, and at least two Soviet COSPAS spacecraft.

Technical consultation and support will continue to conduct radio interference, propagation, and special system studies required for the

growth of existing satellite services and the inclusion of new satellite applications. Support to the Department of State, Federal Communications Commission, and the National Telecommunications and Information Administration, in preparing for a series of World Administrative Radio Conferences on geostationary orbit planning for all space services is continuing, as are broadcast satellite and mobile communications planning activities.

Information systems will continue to provide timely development of systems capabilities to meet the needs of space science and applications flight missions. Specific examples are the ocean pilot system, high speed processor for Landsat (Thematic Mapper), and common executive software for image processing.

Committee comment

The NASA request for Space Applications was $316,300,000. This represents a reduction from the fiscal year 1982 request of $372,900,000 and the current fiscal year operating plan which is $325,800,000. Since fiscal year 1980, the Space Applications program has been reduced by 29 percent. At a time when this area of the NASA budget has been severely reduced, the French have announced their plan to proceed with an operational remote sensing system, the Japanese and Europeans have committed to advanced satellite communications programs, using the 30/20 ghz frequency band and the Germans and other nations are pursuing materials processing activities. It should be increasingly apparent to this country that other nations are not going to stand by and wait for U.S. initiatives in space. They clearly see economic and other paybacks from their research and development investment in these areas and intend to reap the economic and technological benefits that will accrue.

Resource observations.—The Committee approved the request for resources observations of $132,200,000. The Committee does want to emphasize the importance of these programs for near-term utilization of space technology and feels strongly that the technology capability must be maintained in order to advance quickly the state of space-based land remote sensing technology. With the launch of Landsat D this year, it is hoped that NASA will continue to sustain its development of advanced sensor technology and will release the thematic mapper data at the earliest possible time to allow users to more rapidly adapt to and utilize the new data sources.

Environmental observations.—The NASA request for environmental observations $128,900,000. The Committee supporter these programs at the requested level.

Technology transfer.—The Technology Transfer program was funded at a $5 million level for fiscal year 1982. No funds were requested for fiscal year 1983 in accordance with the decision that these efforts should be done by the private sector. Although the Committee did not add money for this activity, it is expected that NASA will make every effort to insure a mechanism is being provided for transferring remote sensing technology to State and local governments. This is particularly important in light of the planned launch of Landsat-D this year.

Materials processing in space.—NASA requested $23,600,000 for fiscal year 1983 for materials processing in space. The Committee

recognizes that the potential benefits of materials processing in space are large as are the risks. The Committee is encouraged by the Joint Venture Agreements and Technical Exchange Agreement that NASA has entered into this year and supports these types of arrangements. In order to exploit fully the potential of materials processing in space, the Committee believes that a strong research base within NASA is essential and expects NASA to sustain a level of effort that will encourage private sector involvement.

The Committee approved the budget for materials processing as requested.

Communications and Information Systems.—NASA requested $19,900,000 for communications and information systems.

Since 1978, there has been concern over the challenge to the preeminence of the United States in the area of satellite communications.

In fiscal year 1980 and 1981, NASA began to look at a series of proof of concept models of components and subsystems that would permit satellite communications operations in the 30/20 Ghz frequency band to relieve orbital and frequency congestion. The proof of concept models will be delivered during fiscal years 1982 and 1983 and will undergo limited end-to-end testing to evaluate their system level performance. However, a decision was made not to pursue efforts leading toward large proof-of-concept hardware demonstrations of new technologies. The premise behind this decision was that industry would do the R & D if it really needed it.

This premise is not supported by any evidence. To the contrary, in general, industry cannot aggregate sufficient funds for research and development of experimental spacecraft. The cost is too great for any individual firm, and industry leaders have testified on numerous occasions that the "high risk, long lead time" research will not be undertaken by them. When NASA provides this seed money for generic, proof-of-concept research, industry can then make operational the technology. NASA's original plan would have put an experimental spacecraft needed for testing research results in orbit in 1986. The current situation is that a launch would be postponed or cancelled.

The restoration of funds by the Committee would enable NASA to go forward with a flight program. However, the Committee requests NASA together with the industry to examine a rescoping of the mission to reduce the total mission cost and still obtain the necessary technology verification.

The Committee has provided an additional $20 million for this effort and therefore approves a funding level of $39,900,000 for communications and information systems activities.

TECHNOLOGY UTILIZATION, $9,000,000

The NASA technology utilization program is designed to enhance national economic growth and productivity through the transfer of new technology resulting from NASA research and development programs to the nonaerospace sectors of the economy. In addition to generating use of aerospace technology in U.S. industry, such technological advances have found use in important public sector areas such as medicine, transportation, environment and public safety. The specific objectives of the program are to accelerate and facilitate the

application and use of new technology thus shortening the time between development of advanced aeronautics and space technologies and their full use in the economy; to encourage multiple secondary uses of NASA technology in industry, education, and Government where a wide spectrum of technological problems and needs exist; to understand more fully the technology transfer process and its impact on the economy, and to manage and optimize the process in a systematic way; and to develop applications of NASA's aerospace expertise—its technology, technologists and unique facilities—to nonaerospace needs of the Nation.

Since the program's inception in 1962, a multifaceted array of transfer mechanisms has evolved—mechanisms designed to facilitate the use of aerospace technology in the public and private sectors of the economy. These mechanisms or project areas include: publications and announcements, industrial applications centers, the Computer Software Management and Information Center (COSMIC), State technology application centers, applications teams, applications engineering and civil systems projects.

Summary of funding levels, fiscal year 1983

Technology dissemination	$3,200,000
Technology applications	5,800,000
Program evaluation and support	----------
Civil systems	----------
Total	9,000,000

During 1981, the civil systems program was brought to a conclusion. A total of 18 projects were completed during the period of 1974–81. Of those 18, 8 have already reached a successful transfer to the public sector. Projects demonstrated in this program area covered water and air pollution, undersea technology, radar archaeology, agro-environmental systems, and radar entomology.

In fiscal year 1983, NASA will continue efforts to meet the requirements of the Space Act to provide for the widest practicable dissemination of technical information resulting from NASA research and development programs. Funding in fiscal year 1983 will continue the dissemination of information concerning NASA technology. NASA will attempt to maintain price levels for technical information for U.S. industry so that access by small business users will not be seriously impaired.

NASA also plans to focus its applications engineering program in the biomedical field. NASA will continue participation to completion of several high priority biomedical projects and maintain biomedical applications team activities in support of selected feasibility studies designed to apply existing aerospace technology to biomedical problems identified in cooperation with the National Institutes of Health and other public sector medical organizations. To achieve this objective, NASA plans to reduce its level of support in the applications of aerospace technology in transportation, environment, and public safety.

Subscriptions to NASA Tech Briefs among engineers, scientists and businessmen in U.S. industry reached the administrative limit of 75,000 distributed copies during the past year, necessitating the estab-

lishment of a "waiting list" pending completion of annual circulation. Nearly 160,000 requests for additional technical information were received by NASA during the past year based on Tech Brief announcements, reflecting substantial continued industrial interest and utility of this primary NASA transfer mechanism.

Committee comment

The NASA technology utilization program is recognized as a model Federal program dedicated to the transfer of NASA technology and know-how to the private sector for social and economic benefits. Results of NASA studies indicate that the demonstrated economic benefits are six times the cost of the technology utilization program.

The Committee strongly supports the technology utilization program and approved a funding of $9 million. The Committee remains concerned about an apparent disregard of congressional intent in the proposed funding request of $4 million for this program. It is therefore expected that NASA will continue this program at an adequate budget level to ensure the continued development and implementation of a technology utilization function that actively applies to the full range of the agency's institutional expertise to non-aerospace technology problems of the industrial and public sectors.

AERONAUTICAL RESEARCH AND TECHNOLOGY PROGRAM, $296,000,000

The objectives of the aeronautical research and technology program are: (a) to advance the science and technology of aeronautics to insure safer, more economical, more fuel efficient, and environmentally acceptable air transportation systems which are responsive to current and projected national needs; (b) to maintain the strong competitive position of the United States in the international marketplace; and (c) to support the Department of Defense in maintaining the superiority of the Nation's military aircraft.

These long-standing national goals have, in past decades, been attained by NASA with efficiency and excellence. Aviation industry technological leadership resulting therefrom has amply repaid Government investment in NASA aeronautics technology. This has been through: net contributions to foreign trade; industry employment in the United States; production of the free world's most advanced military aircraft; a 1980–81 fatality free scheduled commercial airline operation in the United States (exclusive of air taxi or commuter service); and multibillion dollar industry tax revenues for the Federal treasury.

These values are now in jeopardy from developments in other countries. Foreign industry consortia, supported by their governments, have so effectively pursued and advanced aeronautics technology that U.S. industry has during the past year suffered severe losses in several important aspects of its export trade. These are even more significant in their portent for the future than in their effect on 1981 trade.

Summary of funding levels, fiscal year 1983

Research and technology base	$182,000,000
Systems technology programs	114,000,000
Total	296,000,000

Research and technology base programs.—The research and technology base program will build on the substantial results of the ongoing program, utilizing the unique NASA experimental facilities, research aircraft, computer capabilities, and expertise now in existence. Fundamental discipline efforts will continue to lead to advances in nonintrusive experimental test techniques and development of analytical and computational methods to better understand and predict aerodynamic characteristics associated with flow over a variety of aircraft shapes to reduce drag and improve performance; metallic, ceramic, polymer, and composite materials for high temperature engine applications and light weight airframe structures; the development of analytical methods to improve life prediction and better understand and control the dynamic response of complex aircraft and engine structures; electronics and highly reliable, fault-tolerant aircraft control system software and architectural concepts; crew station technology and capability of modeling pilot behavior in a multivariable environment; computational methods able to predict complex internal flow through rotating blade rows in turbomachinery and modeling of combustion processes in engines to control emissions; and a better understanding of the impact of alternative fuels on engine performance. The dicipline and vehicle-oriented research and technology base efforts in the various speed regimes will continue to pursue wind tunnel investigations on advanced aircraft and rotorcraft configurations, and to examine the effects of propulsion technology advances individually and in combination.

The NASA request for the research and technology base was $182 million.

Systems technology programs.—The systems technology programs of NASA encompass the following role. They extend the scientific discoveries and findings flowing from the research and technology base through applied research to demonstration and validation for selective technologies which thereafter provide the design base for advanced military and commercial products undertaken by private industry.

The NASA request for systems technology efforts would continue on advanced rotorcraft concepts and technology for future military aircraft. The rotorcraft activity will include research on new rotor configurations and other advances in joint programs with the U.S. Army. The high speed activity will investigate advanced technology and new configurations approached in cooperative wind tunnels and flight research programs with the Air Force, Navy, and Defense Advanced Research Projects Agency.

However, the request also deemphasized systems technology to reflect the objective of reducing the Federal role in those areas which directly support industrial product development. The systems technology programs being reduced by the proposed budget in fiscal year 1982 and planned for termination prior to fiscal year 1983 include: aeronautical systems studies, an integrated program for aerospace vehicle design, aeroelasticity of turbine engines, broad property fuels technology, helicopter transmission technology, powered lift technology, tilt rotor systems technology, laminar flow control, energy efficient transport, composite primary aircraft structures, terminal

configured vehicle, energy efficient engine development, the advanced turboprop program, and technology programs directed toward general and commuter aviation development.

The fiscal year 1983 systems technology portion of the aeronautical research and technology program as proposed ($50 million) would contain only the high speed and low speed budget categories. These efforts have a strong direct interdependence with national aeronautical research programs of the Department of Defense and would be, beginning in fiscal year 1983, the only focused systems technology activities within the aeronautics research and technology program. Systems technology programs needed for civil and commercial aviation development would become the responsibility of the private sector while continuing to draw support from the more fundamental research activities conducted within the research and technology base.

Committee comment

Until the present decade, U.S. sales of large transport aircraft to non-U.S. airlines accounted for about 90 percent of the total of such sales. But in 1981 Airbus Industrie alone accounted for 42 percent of such sales, Boeing 51 percent, McDonnell Douglas 2 percent, Lockheed 2 percent, and all others 3 percent. In fact, Lockheed was forced last year to a decision to withdraw from the civil transport market. Future implications are underscored by further analysis of those sales results. About 85 percent of Boeing's sales in 1981 were to old customers, largely for reorders of existing models and for orders of new models, with only about 15 percent consisting of sales to new customers. About 65 percent of Airbus sales were to new customers, thereby establishing a base for dominating the future reorder business which has traditionally accounted for as much as 70 percent of the total sales of any manufacturer's aircraft.

The magnitude of the implications on future sales can be seen in data provided to the Subcommittee on Science, Technology, and Space in its hearing on April 1, 1982 by Dr. Stephen Piper, Coordinator, Aerospace Trade Policy, Office of the United States Trade Representative "Nearly 4,000 older 2–3-engine jet aircraft now in service, most of which are of U.S. manufacture are expected to be replaced by new generation transports." That replacement market, accelerating from the later 80's into the 90's will have a sales value of $100 to $125 billion in 1980 dollars. Including market growth through the decade of the 90's, another $100 to $150 billion of transport aircraft sales can be expected. The competition for that market will be largely shaped by marketing performance in the interim, by affected countries export financing policies and by the technological attributes of the competing aircraft, featuring particularly fuel efficiency, lower noise level, increased reliability and production cost.

The trend in general and commuter aviation world trade is of equal concerns to the Committee. During 1981 this segment of the U.S. aircraft industry encountered its first year ever of a negative trade balance. In testimony previously cited the U.S. Trade Representative's witness listed 22 types of commuter aircraft in production or development of which only three involve U.S. manufacturers. A previous study by the Aerospace Corp. indicated a 20 year 1980–2000

world market exceeding 5,000 new aircraft, offering between 15 and 60 seats for this segment of the airline industry.

The Committee carefully evaluated the expectation of the administration that the aviation industry would itself provide the funding required to carry on the commercially oriented systems technology programs deleted from its fiscal year 1983 budget proposal. In testimony before the Subcommittee on Science, Technology, and Space at its hearing on February 23, the Administrator of NASA acknowledged that no indication to that effect was available from industry. That situation was reaffirmed by NASA during another subcommittee hearing on April 1. A professional assessment of the ability of the industry to assume that technology development burden was provided by an outside independent witness in his testimony before the subcommittee at the same hearing on April 1. This witness was Wolfgang H. Demisch, a specialist in the aerospace industry and vice president of Morgan Stanley and Co., Inc. He pointed out even after technology readiness has been demonstrated by successful completion of an array of systems technology programs, an airframe company must risk about $2 billion to bring a new aircraft to market. "Given this high inherent market uncertainty," he added, "management would be suicidal to accept technical unknowns as well." On the question of whether industry could fulfill this systems technology development role which NASA proposed to discontinue, he stated:

> NASA is best positioned to address the technical uncertainties inherent in aerospace, the "will it work" part. Its infrastructure is the best in the business, and its personnel have the best overview of the technical options available to solve problems most efficiently. NASA can interact freely with both industry and the academic world. It receives problems and data both from the military and the commercial arenas, and can cross fertilize between the disciplines in ways impossible to industry, where airframes, propulsion, and subsystems are generally split among several companies, which are mutually competitive, rather than positioned to share their insights or problems. Indeed, antitrust restrictions would forbid such sharing.

He concluded,

> For a truly trivial savings, we risk vandalizing an efficient and productive mechanism for bringing the best skills of the nation to bear on the most pressing problems of one of our most successful industries * * * And yet, once destroyed it will not be easily restored.

In the judgment of the Committee, there is too much of the national interest at risk to tamper with an established institutional arrangement which has provided the technology development for a $65 billion industry providing over 1.25 million jobs and contributing $13 billion net to the Nation's trade balance.

The Committee views these developments and potential impacts as a clear signal to strengthen the previously cited objective (b) of NASA's aeronautical research and technology program, "to maintain the strong competitive position of the United States in the international marketplace." Lack of commitment to that objective is dis-

tressingly clear in the proposed budget request's elimination in fiscal year 1983 of seven systems technology programs retaining only those two which are oriented toward military requirements. Accordingly, the Committee action restores, by reprogramming within the agency total funding request, $64 million specifically toward continuation of six of those seven systems technology programs.

The Committee intent is that $64 million be allocated to the systems technology programs as follows: Aeronautical Systems Studies ($2 million), Turbine Engine Hot Section ($2.5 million), Broad Property Fuels ($3 million), Helicopter Transmission ($1.5 million), Critical Aircraft Resources ($2.2 million), General and Commuter Aviation ($3 million), Composite Primary Aircraft Structure ($6 million), Energy Efficient Transport ($1.1 million), Terminal Configured Vehicle ($4.6 million), Laminar Flow Control ($3 million), Energy Efficient Engine ($7.5 million), and Advanced Turboprop ($27.6 million).

SPACE RESEARCH AND TECHNOLOGY PROGRAM, $133,000,000

The objective of the space research and technology program is to provide the technology base upon which all future national space activities depend. This advanced technology has direct applications to both current and future space missions and, in large part, provides technology options which will enable missions that will not otherwise be possible.

It is difficult to quantify the value of investment in advanced space research and technology. Without prior advancements in technology, the United States would not occupy its present position of leadership in the space arena. The future maintenance of this position depends on the achievement of the objectives of this program. The fiscal year 1983 program continues to pursue these objectives by stressing those technology areas judged to be most critical by external advisory groups, by in-house program assessment, and by the future users of the technology. Emphasis will be placed on advancements in disciplinary technologies required for the enhancement of planned missions and the enabling of future missions which are beyond current capabilities.

Summary of funding levels, fiscal year 1983

Research and technology base	$125,600,000
Systems technology programs	4,400,000
Standards and practices	3,000,000
Total	133,000,000

In fiscal year 1983, activities will focus on maintaining a strong research and technology base in the disciplinary areas of aerothermodynamics, chemical propulsion, materials and structures, electronics and automation, and space power and electric propulsion. These are the only NASA advanced research and technology programs designed to support and extend these critical aerospace disciplines.

Activities in information, spacecraft, and transportation systems research and technology are designed to study the interrelationships of discipline technology from an integrated systems point of view, and are critical to the successful transition of technology from the laboratory to useful application. In addition, systems-level studies conducted

within the research and technology base will continue to focus the discipline and system research and technology activities in directions which will lead to maximum benefits from available resources. Finally, systems technology programs involving the extension of ground-based research and technology activities to space using Shuttle, Spacelab, and free-flying vehicles will be continued. During fiscal year 1983, a number of space technology experiments will be performed aboard the Shuttle/Spacelab.

The objective of the standards and practices program is to provide an agency focal point for all program assessment functions relative to program assurance, safety, standards, practices, and special project activities to insure mission integrity. This includes responsibility for overall review of the technical execution of all NASA programs to assure that the development efforts and mission operations are being planned and conducted on a sound engineering basis with proper programmatic controls. Specifically, the objectives are to: maintain an overview of the technical execution of NASA programs; address technical problems highlighted in reviews; review program plans/project execution; conduct surveys and special investigations related to program execution, reliability, quality assurance, including parts and materials assurance, and aviation and system safety; develop policies; monitor compliance; issue experience bulletins on program assurance related issues; develop handbooks and guidelines governing reliability, quality assurance, software, safety, and other practices; and, to participate with the interagency and industry groups in activities fostering better cooperation on programs and issues of mutual interest.

In support of the objectives of the agency, the fiscal year 1983 standards and practices program will continue to conduct activities related to reliability and quality assurance, systems and aviation safety, software assurance, and program practices to reduce program risks, improve product confidence, and encourage good program practices in the technical execution of NASA programs. The fiscal year 1983 standards and practices program principally provides for continuity in addressing engineering and technical concerns related to the NASA space program activities. For this budget year, the funding estimates do not project any major departures from the prior year activities. Standards and practices will continue to maintain an overview of the technical execution of NASA programs, address technical problems highlighted in reviews, review program plans and project execution, evaluate technical readiness of systems to perform missions, and conduct surveys and special investigations related to program execution, reliability, quality assurance, and systems safety. In each of the cognizant areas, activities are anticipated and programs will be conducted which assist the rapid identification and solution of technical problems that surface at technical reviews or are encountered in test or operational program activities, or which will contribute to the long-range goal of increased confidence in the ability of the programs to meet their mission goals. Increased emphasis is planned in fiscal year 1982 and fiscal year 1983 in systems and aviation safety related activities, and in support of improved management of software in NASA programs.

Committee Comment

The Committee recognizes that a strong space research and technology base is vital to maintain our Nation's leadership in space and

to pursue an aggressive space program. With increasing competition from foreign nations in areas of advanced satellite communications, remote sensing technologies, materials processing. and scientific research, adequate levels for this space systems technology base become even more critical in providing options for both the commercial and Government sectors to meet this competition. Consequently, the Committee has provided $133 million for the purposes of strengthening the research and technology base, an increase of $10 million above the budget request.

The Committee is concerned about the fragmentation of the advanced nuclear power systems program, and in particular the lack of a designated lead Government agency. Therefore, the Committee urges NASA to initiate discussions with the Department of Energy and the Department of Defense to determine which agency should have primary program responsibility in order to insure coherent progress in the program.

ENERGY TECHNOLOGY PROGRAM, $0

The major goal of the energy technology program has been to apply NASA aeronautics and space technologies, experience, and facilities to the energy research and development needs of the Nation, and to understand, evaluate and define how NASA capabilities can be applied to exploit the unique characteristics of the space environment to help solve energy related problems on Earth. These objectives have been accomplish through NASA-funded exploratory programs in energy technology areas that have had close affinities to established NASA expertise. The efforts have subsequently been converted into reimbursable programs that exploit unique NASA capabilities.

The deletion of funds in fiscal year 1982 and fiscal year 1983 reflects the decision to phase out the NASA directly funded energy technology identification program.

Summary of funding levels, fiscal year 1983

Energy technology	$0

TRACKING AND DATA ACQUISITION PROGRAM, $508,900,000

The purpose of this program is to provide vital tracking, command, telemetry, and data acquisition support to meet the requirements of all NASA flight projects. In addition to NASA flight projects, support is provided for projects of the Department of Defense, and on a reimbursable basis to other Government agencies, commercial firms, and other countries and international organizations engaged in space research endeavors.

Support is provided for sounding rockets, research aircraft, Earth orbital and suborbital missions, planetary spacecraft, and deep space probes. The program also includes the support of all phases of the Space Shuttle flight program. The various types of support provided include: (a) tracking to determine the position and trajectory of vehicles in space; (b) acquisition of scientific and space applications data from on-board experiments and sensors; (c) acquisition of engineering data on the performance of spacecraft and launch vehicle systems; (d) transmission of commands from ground stations to spacecraft; (e) communication with astronauts; (f) transfer of information be-

tween the various ground facilities and central control centers; (g) processing of data acquired from the launch vehicles and spacecraft; and (h) reception of television transmission from space vehicles. Such support is essential for achieving the scientific objectives of all flight missions, for executing the critical decisions which must be made to assure the success of these flight missions, and, in the case of Shuttle missions, to insure safety of the crew.

Tracking and acquisition of data for the spaceflight projects is accomplished through the use of a worldwide network of NASA ground stations. When the Tracking and Data Relay Satellite System becomes operational, tracking support will be provided by a system of tracking and data relay satellites in geosynchronous orbit. Ground facilities are interconnected by ground communications lines, undersea cables, and communications satellite circuits which are leased from communications carriers, both domestic and foreign. This interconnection provides the communications capability needed between spacecraft and the control centers from which the flights are directed.

Summary of funding levels, fiscal year 1983

Operations	$338,200,000
Systems implementation	96,000,000
Advanced systems	13,400,000
Tracking and data relay satellite system	61,300,000
Total	508,908,000

The operations program provides for manpower and services needed to operate the worldwide network of NASA ground facilities including tracking stations, mission control centers, computation and data processing facilities, and support instrumentation for sounding rocket and aeronautics programs, and to provide the communications required in support of NASA programs. The fiscal year 1983 funding request provides support to approximately 50 automated Earth orbiting and planetary missions. The funds requested for operations also provide for support of Space Shuttle flights and for the pre-launch support activity required for upcoming approved programs such as Spacelab, Gamma Ray Observatory, Galileo, Tracking and Data Relay Satellite System (TDRSS).

The objectives of the NASA tracking and data system implementation program are to maintain the existing ground support capability at a high level of proficiency and reliability in order to meet the support needs of the many and varied space missions, and to provide augmentation of this capability, as necessary, to meet the special requirements of individual flight projects. These ground support systems consist of the tracking and communications networks, control centers, data processing facalities and aeronautics and sound and rocket support instrumentation. The systems implementation program encompasses the engineering, design, and procurement of the necessary equipment, subsystems, and systems in response to the requirements of the various flight missions and other research projects. It also includes related documentation and basic software, the purchase of large module spares, and the acceptance testing, integration, and checkout of equipment.

The objectives of the advanced systems program is to perform studies and conduct the development of tracking and data systems

and techniques required to: (1) obtain new and improved tracking and data capabilities that will meet the needs of approved new missions and near term new starts, and (2) improve the cost effectiveness and obtain the reliability needed for overall support of the total mix of spaceflight missions. This effort also includes investigations of upcoming missions and trade-off studies of ground systems and telecommunications links to determine design approaches and overall trade-offs for the lowest life-cycle costs to support future space missions.

The objective of the Tracking and Data Relay Satellite System (TDRSS) is to provide tracking, command, and telemetry services to all low-Earth orbital missions. TDRSS will consist of a four satellite constellation in geosynchronous orbit and a single ground station located at White Sands, N. Mex. Of the four satellites on-orbit, two will be dedicated to NASA use, one will provide Space Communications Co. commercial service, and the fourth will serve as an on-orbit spare to assure the reliability of both NASA and commercial services. The NASA service will provide both increased high data rate capability and greatly expanded mission coverage over that currently provided via traditional ground stations. When TDRSS becomes fully operational, a number of manpower intensive ground stations servicing low-Earth orbital missions will be phased out.

Committee comment

The Committee approved the budget of $508.9 million for Tracking and Data Acquisition as requested.

Construction of facilities—Summary

1. Construction of data analysis facility, Hugh L. Dryden Flight Research Facility	$4,500,000
2. Rehabilitation and modification of utility systems, Goddard Space Flight Center	2,840,000
3. Modifications to the 4-by-7 meter low speed tunnel, Langley Research Center	7,200,000
4. Modifications to upgrade the transomic dynamics tunnel; Langley Research Center	9,000,000
5. Modifications of rocket engine test facility for altitude testing, Lewis Research Center	995,000
6. Modification to 450 psi air system in engine research building, Lewis Research Center	2,920,000
7. Rehabilitation of airfield, Wallops Flight Center	2,150,000
8. Space Shuttle facilities at various locations as follows:	
A. Modifications to solid rocket booster refurbishment and subassembly facilities John F. Kennedy Space Center	1,700,000
B. Modification of manufacturing and final assembly facilities for external tanks, Michoud Assembly Facility	17,845,000
C. Minor Shuttle-unique projects, various locations	
9. Space Shuttle payload facility: Rehabilitation and modification for payload ground support operations, John F. Kennedy Space Center	1,740,000
10. Repair of facilities at various locations, not in excess of $500,000 per project	15,000,000
11. Rehabilitation and modification of facilities at various locations, not in excess of $500,000 per project	20,000,000
12. Minor construction of new facilities and additions to existing facilities at various locations, not in excess of $250,000 per project	4,000,000
13. Facility planning and design not otherwise provided for	8,250,000
Total	100,000,000

The Construction of Facilities (CoF) appropriation is for contractual services for repair, rehabilitation and modification of existing facilities; the construction of new facilities; the acquisition of related facility equipment; the design of facilities projects and advance planning related to future facilities needs.

The funds requested for 1983 provide for: the continuation of prior year's endeavors in meeting the facilities requirements for the Space Shuttle; Space Shuttle Payload support operations; modification of aeronautical research and development facilities; repair, rehabilitation, and modification of other facilities to maintain, upgrade and improve the usefulness of the NASA physical plant; minor construction of new facilities; and facility planning and design activities.

The projects and amounts in the budget estimate reflect Space Shuttle payload requirements that are time sensitive to meet specific milestones. Other program requirements for 1983 include the construction of a data analysis facility at the Ames' Dryden Flight Research Facility; rehabilitation and modification of utility systems at the Goddard Space Flight Center and rehabilitation of the Airfield at Goddard's Wallops Flight Center; modifications to the transonic dynamics tunnel and modifications to the 4- by 7-meter low speed tunnel at the Langley Research Center; and, modifications of the 450 PSI air system and modification of rocket engine test facility for altitude testing at the Lewis Research Center.

The fiscal year 1983 program continues to meet the objectives of preserving and enhancing the capabilities and usefulness of existing facilities and to ensure safe, economical, and efficient use of the NASA physical plant. This request continues the necessary rehabilitation and modification program as in prior years and continues a repair program. The purpose of the repair program is to restore facilities to a condition substantially equivalent to their originally designed capability. The minor construction program continues to provide a means to accomplish smaller facility projects which accommodate changes in technical and institutional requirements. This program also includes projects which continue NASA efforts to reduce the consumption of energy.

Funds requested for facility planning and design cover advance planning and design requirements for potential future projects, master planning, facilities studies, engineering reports and studies and the preparation of facility project design drawings and bid specifications.

Committee comment

The Committee is concerned that since 1980 the Construction of Facilities budget has decreased by more than 50 percent in constant dollars. Additionally the percentage of the NASA budget which is for Construction of Facilities has decreased from 3.3 percent to 1.6 percent. This represents a potentially serious deterioration of the NASA physical plant which is critical to its leadership in space and aeronautics research and development. The Committee approved a budget of $110 million which includes an additional $10 million for high priority projects which have been previously deferred.

The Research and Program Management appropriation funds the performance and management of research, technology and test activities at NASA installations, and the planning, management and support of contractor research and development tasks necessary to meet the Nation's objectives in aeronautical and space research. Objectives

Research and program management—summary, fiscal year 1983

Personnel and related costs	$829,900,000
Travel	24,100,000
Operation of installation	324,900,000
A. Facilities services	(179,881,000)
B. Technical services	(55,526,000)
C. Management and operations	(89,493,000)
Total	1,178,900,000

of the efforts funded by the Research and Program Management appropriation are to (1) provide the technical and management capability of the civil service staff needed to conduct the full range of programs for which NASA is responsible, (2) maintain facilities and laboratories in a state of operational capability and manage their use in support of research and development programs, and (3) provide effective and efficient technical and administrative support for the research and development programs. More than 21,200 civil service personnel at eight installations and Headquarters are funded by the Research and Program Management appropriation. This civil service workforce is NASA's most important resource and is vital to future space and aeronautics research activities. Seventy percent of the Research and Program Management appropriation is needed to provide for salaries and related costs of this civil service workforce. About 2 percent is for travel, which is vital to successfully manage the Agency's in-house and contracted programs. The remaining amount of the Research and Program Management appropriation provides for the research, test and operational facility support, and for related goods and services necessary to successfully operate the NASA installations and to efficiently and effectively accomplish NASA's approved missions.

Committee comment

The Committee approved the $1,178.9 million budget request for research and program management for fiscal year 1983.

Estimated Costs

In accordance with paragraph 11(a) of rule XXVI of the Standing Rules of the Senate and section 403 of the Congressional Budget Act of 1974, the Committee provides the following cost estimate, prepared by the Congressional Budget Office:

U.S. Congress,
Congressional Budget Office,
Washington, D.C., May 26, 1982.

Hon. Bob Packwood,
Chairman, Committee on Commerce, Science and Transportation, U.S. Senate, Washington, D.C.

Dear Mr. Chairman: Pursuant to Section 403 of the Congressional Budget Act of 1974, the Congressional Budget Office has prepared the attached cost estimate for the National Aeronautics and Space Administration Authorization Act, 1983.

Should the Committee so desire, we would be pleased to provide further details on this estimate.

Sincerely,

Alice M. Rivlin,
Director.

CONGRESSIONAL BUDGET OFFICE—COST ESTIMATE

MAY 26, 1982.

1. Bill number: Not yet assigned.

2. Bill title: National Aeronautics and Space Administration Authorization Act, 1983.

3. Bill status: As ordered reported by the Senate Committee on Commerce, Science and Transportation, May 11, 1982.

4. Bill purpose: The bill authorizes the appropriation to the National Aeronautics and Space Administration (NASA) of $6,613 million for fiscal year 1983: $5,324 million for research and development, $110 million for construction of facilities, and $1,179 million for research and program management. The authorization for research and development includes $1,808 million for the space shuttle, $1,448 million for space flight operations, $492 million for physics and astronomy, $336 million for space applications, $296 million for aeronautical research, and $509 million for tracking and data acquisition. The bill also authorizes such additional amounts as may be necessary for increases in salary, pay, retirement, or other employee benefits.

The amounts authorized equal the President's request for NASA in fiscal year 1983, but include $10 million less for research and development and $10 million more for construction of facilities. The $6,613 million authorization exceeds the fiscal year 1982 appropriations to date by $673 million.

In addition, section 5 of the bill requires the Secretary of Defense to transfer to NASA such sums as may be necessary to pay the costs of placing Defense Department payloads into orbit via the Space Shuttle. In calculating the amount of the transfer, the NASA Administration is to include both direct and indirect costs to NASA of all launch and flight services provided for Defense Department payloads, along with a credit for the fair value of all launch operations performed or scheduled to be performed by the Department of Defense for the benefit of NASA. This section applies to any Defense payloads placed into orbit on or after October 1, 1983.

5. Cost estimate:

[By fiscal years, in millions of dolars]

	1983	1984	1985	1986	1987
Estimated authorization level:					
NASA—Civilian space program (function 250)	6,317				
NASA—Aeronautics (function 400)	296				
NASA—Allowance for pay increase (function 920)	55				
Total	6,668				
Estimated outlays:					
NASA—Civilian space program (function 250)	4,630	1,454	221	12	
NASA—Aeronautics (function 400)	276	13	7		
NASA—Allowance for pay increase (function 920)	52	3			
Total	4,958	1,470	228	12	

6. Basis of estimate: The estimate assumes that the full amounts authorized will be appropriated prior to the beginning of fiscal year 1983. The increase in salaries and benefits was estimated at 6.74 percent of the personnel compensation provided by the authorization. CBO

estimates that an additional $55 million will be necessary for this increase. Estimated annual outlays are based on historical spending patterns of the major NASA programs.

According to information from NASA and the Department of Defense, the specific payloads to be placed in orbit in the next five fiscal years and the pricing policy to be used in assigning costs have not yet been established. Consequently, CBO has no basis for estimating the amount of funds to be transferred between the two organizations. NASA and the Defense Department are expected to finalize their new pricing policy before the beginning of fiscal year 1983.

7. Estimate comparison: None.

8. Previous CBO estimate: On May 5, 1982, the Congressional Budget Office prepared a cost estimate for H.R. 5890, a similar bill ordered reported by the House Committee on Science and Technology, April 28, 1982. The House Committee bill specifically authorized $6,647 million for 1983 NASA activities, compared to the $6,613 million authorized in this bill.

9. Estimate prepared by: Steve Martin.

10. Estimate approved by:

JAMES L. BLUM,
Assistant Director for Budget Analysis.

REGULATORY IMPACT STATEMENT

In accordance with paragraph 11(b) of rule XXVI of the Standing Rules of the Senate, the Committee provides the following evaluation of the regulatory impact of the legislation, as reported.

This bill authorizes the appropriation of funds for the conduct of space and aeronautical research and development activities to carry out the policy and purpose of the National Aeronautics and Space Act of 1958. These activities are conducted in NASA laboratories by NASA personnel and through contracts with industry, universities and research institutions for research and development and for supporting scientific and technical services. The Committee has concluded the nature of these activities is such that there is no regulatory impact on individuals and businesses and, no effect on Federal paperwork or individual privacy.

SECTION-BY-SECTION ANALYSIS

Section 1

Subsections (a), (b), and (c) would authorize to be appropriated to the National Aeronautics and Space Administration funds, in the total amount of $6,612,900,000, as follows: (a) for "Research and development," a total of 11 program line items aggregating the sum of $5,324,000,000; (b) for "Construction of facilities," a total of $110,000,000; and (c) for "Research and program management," $1,178,900,000. Subsection (c) would also authorize to be appropriated such additional or supplemental amounts as may be necessary for increases in salary, pay, retirement, or other employee benefits authorized by law.

Subsection (d) would authorize the use of appropriations for "Research and development" without regard to the provisions of subsection (g) for: (1) items of a capital nature (other than the acquisi-

tion of land) required at locations other than NASA installations for the performance of research and development contracts; and (2) grants to nonprofit institutions of higher education, or to nonprofit organizations whose primary purpose is the conduct of scientific research, for purchase or construction of additional research facilities. Title to such facilities shall be vested in the United States unless the Administrator determines that the national program of aeronautical and space activities will best be served by vesting title in any such grantee institution or organization. Moreover, each such grant shall be made under such conditions as the Administrator shall find necessary to insure that the United States will receive benefit therefrom adequate to justify the making of that grant.

In either case, no funds may be used for the construction of a facility in accordance with this subsection, the estimated cost of which, including collateral equipment, exceeds $250,000, unless the Administrator notifies the Speaker of the House, the President of the Senate and the specified committees of the Congress of the nature, location, and estimated cost of such facility.

Subsection (e) would provide that, when so specified and to the extent provided in an appropriation act, (1) any amount appropriated for "Research and development" or for "Construction of facilities" may remain available without fiscal year limitation, and (2) contracts for maintenance and operation of facilities, and support services may be entered into under the "Research and program management" appropriation for periods not in excess of 12 months beginning at any time during the fiscal year.

Subsection (f) would authorize the use of not to exceed $25,000 of the "Research and program management" appropriation for scientific consultations or extraordinary expenses, including representation and official entertainment expenses, upon the authority of the Administrator, whose determination shall be final and conclusive.

Subsection (g) would provide that of the funds appropriated for "Research and development" and "Research and program management," not in excess of $75,000 per project (including collateral equipment) may be used for construction of new facilities and additions to existing facilities, and for repair, rehabilitation, or modification of facilities.

Section 2

Section 2 would authorize upward variations of the sums authorized for the "Construction of facilities" line items (other than facility planning and design) of 10 percent at the discretion of the Administrator or his designee, or 25 percent following a report by the Administrator or his designee to the Committee on Science and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate on the circumstances of such action, for the purpose of meeting unusual cost variations. However, the total cost of all work authorized under these line items may not exceed the total sum authorized for "Construction of facilities" under section 1 (b), paragraphs (1) through (13).

Section 3

Section 3 would provide that not more than one-half of 1 percent of the funds appropriated for "Research and development" may be trans-

ferred to the "Construction of facilities" appropriation and, when so transferred, together with $10 million of the funds appropriated for "Construction of facilities," shall be available for the construction of facilities and land acquisition at any location if the Administrator determines (1) that such action is necessary because of changes in the aeronautical and space program or new scientific or engineering developments, and (2) that deferral of such action until the next authorization act is enacted would be inconsistent with the interest of the Nation in aeronautical and space activities. However, no such funds may be obligated until 30 days have passed after the Administrator or his designee has transmitted to the Speaker of the House, the President of the Senate and the specified committees of Congress a written report containing a description of the project, its cost, and the reason why such project is necessary in the national interest, or each such committee before the expiration of such 30-day period has notified the Administrator that no objection to the proposed action will be made.

Section 4

Section 4 would provide that, notwithstanding any other provision of this Act—

(1) no amount appropriated pursuant to this Act may be used for any program deleted by the Congress from requests as originally made to either the House Committee on Science and Technology or the Senate Committee on Commerce, Science, and Transportation,

(2) no amount appropriated pursuant to this act may be used for any program in excess of the amount actually authorized for that particular program by sections 1(a) and 1(c), and

(3) no amount appropriated pursuant to this act may be used for any program which has not been requested of either such committee,

unless (A) a period of 30 days has passed after the receipt by the Speaker of the House, the President of the Senate and each such committee of notice given by the Administrator or his designee containing a full and complete statement of the action proposed to be taken and the facts and circumstances relied upon in support of such proposed action, or (B) each such committee before the expiration of such period has transmitted to the Administrator written notice to the effect that such committee has no objection to the proposed action.

In calculating the 30 days period referred to in the preceding sentence, any days on which either House is not in session because of an adjournment sine die or an adjustment of more than 3 days to a day certain shall be excluded, but in no extent shall the total period extend beyond 30 days.

Section 5

Subsection (a) would direct the Secretary of Defense, notwithstanding any other provision of law or any interagency agreement to transfer to the NASA Administrator such sums as might be necessary to pay full costs of placing Department of Defense payloads into orbit by means of the Space Shuttle.

Subsection (b) states that any transfer of funds pursuant to this section shall cover both direct and indirect costs of all launch services

and flight services associated with placing the payload in orbit including, but not limited to, materials and services, launch operations, and flight operations. In the event of a multi-purpose mission involving both defense and non-defense activities, the total cost of the mission shall be allocated on an equitable basis. In calculating costs under this section, the Administrator may include a credit for the fair value of Space Shuttle launch operations performed (or scheduled to be performed in the succeeding 12 months) by the Department of Defense for the benefit of the National Aeronautics and Space Administration.

Subsection (c) applies section 5 to any Department of Defense payloads placed into orbit by means of the Space Shuttle on or after October 1, 1983.

Section 6

Section 6 would express the sense of the Congress that it is in the national interest that consideration be given to geographical distribution of Federal research funds whenever feasible and that the National Aeronautics and Space Administration should explore ways and means of distributing its research and development funds whenever feasible.

Section 7

Section 7 states that this Act may be cited as the "National Aeronautics and Space Administration Authorization Act, 1983".

Section 8

Requires the Director of the Federal Emergency Management Administration to continue the operation of the U.S. Fire Administration. The Director of FEMA is required to reserve not less than $20 million of funds appropriated to operate FEMA to conduct the operations of the U.S. Fire Administration, including the United States Fire Academy, and any other functions and responsibilities that are vested in the Director under the Federal Fire Prevention and Control Act of 1974. This section is not intended to increase the total authorization for the operations of FEMA; rather, it is intended to require that at least $20 million of the funds appropriated to carry on all of the activities of FEMA be set aside for the operation of the U.S. Fire Administration.

Rollcall Votes in Committee

In accordance with paragraph 7(c) of rule XXVI of the Standing Rules of the Senate, the Committee provides the following record votes during its consideration of S. 2604:

Senator Heflin offered an amendment to delete $150 million for the Centaur high energy upper stage and substitute continued procurement of the intertial upper stage.

On the following rollcall vote there were 10 nays to 6 yeas and the Heflin amendment was defeated.

YEAS (6)	NAYS (10)
Kassebaum [1]	Packwood
Gorton	Goldwater [1]
Long	Schmitt
Ford	Danforth
Exon [1]	Pressler
Heflin	Stevens [1]
	Kasten
	Cannon
	Inouye
	Riegle [1]

[1] By proxy.

Without objection, the Committee ordered favorably reported an original bill to authorize $6,612,900,000 for fiscal year 1983 for the National Aeronautics and Space Administration without amendments.

Changes in Existing Law

In compliance with paragraph 12 of rule XXVI of the Standing Rules of the Senate, changes in existing law made by the bill, as reported, are shown as follows (existing law proposed to be omitted is enclosed in black brackets, new material is printed in italic, existing law in which no change is proposed is shown in roman):

The bill as reported would make no changes in existing law.

ADDITIONAL VIEWS OF MR. HEFLIN

I commend Senator Schmitt, the Chairman of the Subcommittee on Science, Technology, and Space, Senator Riegle, the Ranking Minority Member, and the Subcommittee staff for their diligent work in drafting the 1983 NASA Authorization Bill. I concur with most of the recommendations made in the bill. However, I disagree with the Committee's decision to add $150 million to the bill for the Centaur upper stage development, which an Air Force study concludes will ultimately cost over $1 billion.

I am opposed to this action for several reasons. First, NASA made a request that the Congress support the use of the Inertial Upper Stage (IUS) in conjunction with the Space Shuttle for a 1985 Galileo launch and a 1966 International Solar Polar Mission (ISPM) launch The IUS is completing development and will be available for both Galileo and ISPM. It meets all requirements for these two missions. However, if the Centaur is used on Galileo, NASA has testified that the launch date will be postponed at least to 1987. NASA in Congressional testimony stated, "The important thing is that we do nothing else that will cause a loss of other projects. Why jeopardize Galileo? The launch is set to go in 1985 on the Inertial Upper Stage. It is a certain plan that can be executed. One other certain thing is that if we switch to Centaur (for the Galileo mission) we will have to slide the launch to 1987. We will have to keep the people at the Jet Propulsion Laboratory on board doing other things. I do not know what we would do with them. If we switch to Centaur, I am very much afraid we will lose the Galileo Mission." I, too, am afraid we will lose Galileo if we switch to the Centaur.

From another perspective, the IUS achieves a significant scientific return for the Galileo mission. Quoting again from NASA's 1982 Congressional testimony, "The use of the IUS for the Galileo mission will attain 100 percent of the science from the Galileo probe, which is the most important part of the mission. The Galileo orbiter would have some reduction in taking photographs of the satellites of Jupiter. But, there would be no more than a 10-percent loss of science by using the IUS on the Galileo mission." Administrator Beggs has stated, "After discussions with the Space Science Board, everyone agrees that the Galileo mission will be a good one on IUS."

The IUS is ready and available. It has been built to interface with the Space Shuttle and the Titan. With its reliability, safety in the cargo bay of the shuttle, and the experience from 10 earlier flights, the highly important and costly Galileo spacecraft and probe will be assured of a successful mission. The use of Centaur on the Galileo mission would be its first flight in that configuration. I question the wisdom of such a decision. With the addition of $150 million for the Centaur in the fiscal year 1983 NASA bill, all we have gained is a slide of two years or more in launch date. NASA testified during fiscal

year 1982 authorization hearings that the Centaur would be considered for use only on the Galileo and ISPM missions. Following that, another stage will have to be developed to meet future requirements.

In his discussion of the status of the IUS vs. Centaur before Congress, Administrator Beggs testified, "NASA was requested (by the Congress) to do a study with the DOD requirements until the early 1990's and there was no need for Centaur now. NASA had two requirements for Centaur. They were the Galileo mission and the International Solar Polar Mission. The IUS is over its major expenditure now. The IUS delivery cost (for the first eight development units) will be about $50–$60 million per copy. The Centaur stage would cost less per flight. But, the front end cost to develop Centaur made us decide to stay with IUS." Mr. Beggs also said, "Through DOD reviews, we are confident that the country can produce an IUS that can handle our (NASA) missions." I agree with Mr. Beggs' statement.

Concerning DOD's near term upper stage requirements, Mr. Peter Aldridge, Undersecretary of the Air Force, is on record before the Congress as saying, "The IUS as currently designed, will meet all DOD payloads out through 1987." He has also stated, "The Centaur does not envelop DOD requirements."

Another concern that I have is that the United States continue to meet our international agreements. NASA and the European Space Agency are presently planning to fly the International Solar Polar Mission on IUS in 1986. I feel that the mission should go forward as planned.

Following 1987, a new High-Energy Upper Stage (HEUS) will be required to carry heavier spacecraft to high orbits above the earth. This new High-Energy Upper Stage will be able to dock with a space station, go to a higher orbit and return to the Shuttle to be refueled, and be fully reusable. It will also have an on-orbit assembly capability, and a marked increase in payload lifting capability (15,000–16,000 pounds) to geosynchronous orbit. With these characteristics in mind, the Centaur falls short of meeting any and all of these criteria for a High-Energy Stage. Furthermore, the High-Energy Upper Stage should be a competitive procurement, unlike the Centaur, which is a sole source procurement to one company. Competition is the life blood of this nation, and through it the best upper stage will be obtained for maximum utilization.

In summary, the IUS development is virtually completed. It is on schedule for a September 1982 launch on Titan and a January 1983 launch of the NASA Tracking and Data Relay Satellite (TDRSS) on the Space Shuttle. The IUS meets all DOD and NASA upper stage requirements through 1987. The Inertial Upper Stage is a part of our space transportation system, and the United States should make maximum utilization of this national resource.

HOWELL HEFLIN.

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